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ABSTRACT BOOK



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Addressing Complex Local and  
Global Issues in Environmental  
Exposure and Health



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## PLENARY & ORAL SESSIONS

Sunday, August 26

The Role of Occupational Studies in Expanding Our Knowledge of Environmental Carcinogens

*Paul Demers, Occupational Cancer Care Ontario, Canada*

**Abstract:** Exposure to environmental contaminants are generally orders of magnitude higher in workplaces than in environmental settings. In addition, occupationally exposed populations are often easy to identify and assess levels of exposure. Because of this, environmental health effects are generally recognized much earlier in workers than in the general population. A classic example that is often used is uranium miners and radon, but there are many more and, in fact, much of what we know of environmental cancer was initially identified in workplace studies. The evaluations of the International Agency for Research on Cancer (IARC) present an excellent opportunity to examine this and recent examples include diesel engine exhaust and pesticides. Well over half of all IARC definite (Group 1), probable (Group 2A), and possible (Group 2B) human carcinogens are occupational. These include industrial chemicals, metals, particles, and radiation, most of which can be encountered in community as well as work settings. The classification of almost all Group 1 occupational carcinogens was based on epidemiologic evidence from workplace studies. While many environmental carcinogens are more easily studied in workplaces, there are some situations where occupational evidence does not work. These include situations where exposures are higher, or occur primarily in, communities and not in workplaces, which may be the case with environmental tobacco smoke or some rare exposures, such as erionite. Another situation is where the excess risk is among a susceptible population, such as the old or young or a genetically predisposed sub-population. A last example is where relative risks are small and only the large environmentally exposed populations provide adequate power (e.g. ambient air pollution). It is essential to continue conducting studies of both occupational and community exposure to expand our knowledge of environmental cancer.

Monday, August 27

Climate Change: the Greatest Public Health Challenge of Our Time

*Gina McCarthy, Harvard T.H. Chan School of Public Health, Boston, MA, USA*

Abstract: Public mistrust of scientists is growing, and a broad anti-scientific movement has gained momentum in the United States that has fueled the enactment of policies at the federal, state and even local levels that threaten public health protections, including actions to mitigate and adapt to our changing climate. The causes of mistrust in science are many and include ineffective or absent engagement of scientists with audiences outside academia and the publication of studies with conflicting results, which fosters confusion and doubt about science among the public. At the same time, science is the backbone of innovation and entrepreneurship that has underpinned efforts to protect public health and natural resources, as well as our economic strength. Given the increasingly complex nature of today's challenges, it is more critical than ever that government officials, business leaders and the general public have access to sound science communicated in ways that allows them to see its relevance to our health and wellbeing. This is particularly true for the issue of climate change; addressing climate change affords the greatest opportunity to improve health in this century. The decisions we make now about how we use energy, harness natural resources, and conduct our lives can improve our health today and provide for a more equitable world for generations to come. The profound challenges that come with climate change and other threats to the global environment will not be solved overnight or without sound science, large investments in technology innovation, and actions across all sectors of society.

## The Health of the Land and Our Culture: Indigenous Rights as Pathways to Healthy Environments

*Eriel Deranger, Indigenous Climate Action, Canada*

Abstract: Indigenous communities are often at the forefronts of Environmental racism. While there are increasing trends of Indigenous peoples moving to cities, their culture, identity and rights are intrinsically connected to healthy lands and eco-systems. Heavy resource extraction upstream, or directly adjacent to, Indigenous lands and territories has led to a host of serious violations to the health, safety and survival of Indigenous communities and rights in Canada. The Alberta tar sands poses one of the most striking examples of how Industrial development has led to the degradation of water, lands, food security and the rights of the Cree, Dene and Metis peoples. Resources extraction is just one example of neo-colonialism - continued inaccessibility to adequate resources, housing, food, water, sanitation and decision making processes has allowed environmental racism to continue unabated in the country. Indigenous ways of living model exemplary low carbon lifestyles. By honoring and implementing Indigenous rights and peoples into land management processes we can find ways and means to achieve true environmental justice. This keynote will explore how Indigenous rights and knowledge are key to addressing the most complex challenges related to the health and safety of our communities.

## 001.01A. Chemical Exposures and Fish Consumption

### 001.01.01. Examining Changes in Persistent Organochlorine Pollutants Following High Consumption of Farmed Atlantic Salmon: Results from an 8-Week Dietary Intervention Study

Thorhallur Halldórsson

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**Abstract:** Background: In 2004 a publication in Science by Hites et al. reported a 10 to 100-fold higher concentrations of persistent organochlorine pollutants (POPs) in farmed Atlantic salmon compared to wild Pacific salmon. These findings generated intense debate on the health-risk-benefits of farmed Atlantic Salmon. Objective: To examine the short-term effect of high consumption of farmed Atlantic salmon on serum POP concentrations. Methods: A 4-arm randomized controlled trial in overweight or obese subjects (BMI: 27.5-32.5 kg/m<sup>2</sup>) assigned to energy-restricted seafood diet over an 8-week period (SEAFOOD-plus, 2004-2005, n=324). Controls were assigned to a fish free diet and one arm was assigned to three meals per week of farmed Atlantic salmon (24 meals), matched for energy. Of these participants 20 male cases (Salmon) and 20 male controls were selected who experienced modest weight loss and concentrations of pp-DDE, HCB and PCBs (congeners no. 118, 138, 153, 170, 180) were measured at baseline and endpoint. Results: Median baseline concentrations for sum of PCBs, pp-DDE and HCB were 1.41, 0.78 and 0.16 ng/mL, respectively. Mean weight loss at endpoint was 4.8kg and 4.5kg in the salmon and control group (p=0.68), respectively. Concentrations of EPA and DHA were significantly increased at endpoint by ~32% in the Salmon group but reduced by ~14% in controls, suggesting compliance to the intervention. At endpoint the mean sum of PCBs was increased by 0.36ng/mL in the salmon group (p=0.22). Lack of significance is unlikely to be explained by weight loss during the intervention as only a minor change of -0.06ng/mL (p=0.84) in PCB concentrations were observed among controls. Individual PCB congeners, pp-DDE and HCB were non-significantly but systematically increased by 6 to 41% of mean levels in the salmon group compared to controls. Conclusion: Our study suggests that high consumption of farmed Atlantic Salmon over a short period does not substantially affect circulating POP levels.

## **001.01.02. Shellfish and Fatty Fish Intake and Fecundability in a North American Prospective Cohort Study**

Lauren Wise

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Abstract: Fatty fish and shellfish are important sources of omega-3 fatty acids, which may improve embryo morphology and fecundity. However, they are also sources of persistent organic pollutants and heavy metals, which may adversely affect fecundity. In a French retrospective cohort study of 3,421 pregnant women, shellfish intake  $\geq 2$  times/week (relative to  $< 2$  times/month) was associated with a 21% reduction in fecundability (average per-cycle probability of conception); fish intake showed little association with fecundability. There have been no prospective studies of these associations. We evaluated intakes of shellfish, fatty fish, and marine fatty acids (sum of eicosapentaenoic acid, docosahexaenoic acid, and docosapentaenoic acid) in relation to fecundability in a prospective cohort study of 3,292 female pregnancy planners from the United States and Canada. At enrollment, women completed a baseline questionnaire on sociodemographics, anthropometrics, behavioral factors, and medical history, and a validated food frequency questionnaire (NIH diet history questionnaire II). Pregnancy status was updated bimonthly for 12 months or until pregnancy, whichever came first. We estimated fecundability ratios (FR) and 95% confidence intervals (CI) using proportional probabilities regression models, adjusted for energy, age, body mass index (BMI), smoking, alcohol, physical activity, intercourse frequency and timing, multivitamin use, race/ethnicity, education, marital status, and parity. We restricted analyses to women with  $\leq 6$  menstrual cycles of attempt time at enrollment. Greater shellfish intake was associated with slightly reduced fecundability ( $\geq 4$  servings/month vs. none: FR=0.87, 95% CI: 0.72-1.07). The shellfish association was stronger among non-users of fish oil supplements (FR=0.77, 95% CI: 0.61-0.98), particularly overweight women (BMI  $\geq 25$  kg/m<sup>2</sup>: FR=0.69, 95% CI: 0.48-1.01). Intakes of fatty fish and marine fatty acids were not appreciably associated with fecundability.

### **001.01.03. Seafood Consumption and Mercury Exposure in Chicago Asian Communities**

Mary Turyk

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Abstract: The Asian population in the U.S. has an elevated mean blood mercury compared with the non-Asian population due to higher frequency of fish consumption. Methyl mercury (MeHg) crosses the placenta and has been shown to affect neurodevelopment in the fetus as well as cardiovascular risk in adults. However, nutrients in fish, such as omega-3 fatty acids (n-3 FA), have beneficial effects on these health endpoints. Thus, fish consumption advice should balance the risks and benefits. We conducted a community assessment of 367 Chinese, Koreans and Vietnamese in Chicago consisting of a survey of fish consumption and cultural dietary practices; hair sampling for Hg; and Hg testing of commonly consumed seafood purchased in Chicago. Mean participant age was 42 years (range 18, 80); 87% were female; 53% had an annual income of <\$20,000 or were eligible for supplemental food assistance; 95% were born outside of the US; and 41% spoke only non-English at home. Seafood consumption preferences varied among the ethnic groups and included species with a range of contaminant and n-3 FA levels. Mercury intake from fish ( $\mu\text{g}/\text{kg}\text{-day}$ ) differed significantly by ethnicity, with the highest intake in Koreans and the lowest in Vietnamese. n-3 FA intake from fish ( $\text{mg}/\text{kg}\text{-day}$ ) was also highest in the Koreans, predominantly due to anchovy consumption. Elevated hair Hg levels ( $>1\mu\text{g}/\text{g}$ ) were detected in 28% of Vietnamese, 18% of Chinese and 11% of Korean participants. Factors significantly associated with hair mercury levels included mercury intake from consumption of fish with low, moderate and high Hg; consumption of locally caught fish; higher BMI; hair dye use; and a less Western-acclimated dietary pattern. These findings will be used to develop messages to decrease exposure to contaminants while maintaining consumption of healthy nutrients in fish in these communities.

#### **O01.01.04. Biomonitoring of Mercury and Persistent Organic Pollutants in Michigan Urban Anglers and Association with Fish Consumption**

Wendy Wattigney

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Abstract: The 32-mile Detroit River and surrounding tributaries have been designated as a Great Lakes Area of Concern due to pollution from decades of municipal and industrial discharges, sewer overflows and urban development. Key pollutants in fish samples from the Detroit River include mercury, polychlorinated biphenyls (PCBs), dichlorodiphenyldichloroethylene (DDE), dioxins and furans. A biomonitoring study was conducted to assess exposures to these persistent toxic substances in Detroit urban anglers who may be at higher exposure risk due to consumption of locally caught fish. Using a modified venue-based sampling approach, 287 adult shoreline anglers along the Detroit River were recruited and participated in the program. Study participants provided blood and urine specimens and completed a questionnaire interview. We examined percentile estimates for total blood mercury, PCBs, DDE, and dioxin-like total toxic equivalency (TEQ) concentrations among study participants compared with the general U.S. population. Multiple linear regression was used to identify important predictors of contaminant concentrations. Quantile regression was used to investigate whether eating locally caught fish had a differential effect at various quantiles of each contaminant. Participants reported eating an average of 20 Detroit River caught fish meals in the past year. The Detroit urban anglers' total blood mercury and PCB concentrations were 2 to 3 times higher than the general U.S. population. Elevated levels of DDE and total TEQ concentrations were not observed in the cohort. Eating more locally caught fish was associated with higher total blood mercury and serum PCB concentrations, and this effect had a larger impact at higher quantiles of these biomarkers. The biomonitoring data served to inform public health officials and guide state and local public health actions to reduce harmful exposures.

## O01.01B. Occupational Exposures and Respiratory Outcomes

### **O01.01.05. Personal and Area Exposure Assessment at a Stainless Steel Fabrication Facility: Evaluation of Inhalable, Thoracic, Time-Resolved PM<sub>10</sub>, and Lung-Deposited Airborne Metals**

Ashley Newton

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Abstract: Occupational exposure to multivalent transition metals in welding fume is associated with a variety of adverse health outcomes, including respiratory and cardiovascular impairment, lung cancer, and metal fume fever. Welding fume was designated a Group 1 carcinogen by an International Agency for Research on Cancer (IARC) working group in 2017 and a lack of data on deposition and clearance of welding fume was identified as a gap in the scientific literature. We conducted a detailed exposure assessment of 18 welders (monitoring two work shifts per person) in a stainless steel fabrication facility, evaluating personal exposure to inhalable and lung-deposited PM and airborne metals as well as area thoracic PM and time-resolved PM<sub>10</sub> airborne metals. Urinary metals biomarkers were also measured pre and post shift. Mean area thoracic PM exposure in each of the three shops was 30.1, 214, and 164  $\mu\text{g}/\text{m}^3$ , respectively on the first day of sampling. During all sampled shifts, 14 area PM<sub>10</sub> airborne metals were measured with 15 minute time resolution and concentration time-series were produced for each day. In the largest shop, mean area chromium exposure was 19.5  $\mu\text{g}/\text{m}^3$ , mean area manganese exposure was 32.3  $\mu\text{g}/\text{m}^3$ , and mean nickel exposure was 5.8  $\mu\text{g}/\text{m}^3$  over the measured shift. Lead, tungsten, copper, molybdenum, and vanadium exposure were all highly variable, exhibiting short-duration peaks of varying intensities. Although there is currently no quantitative occupational exposure limit for welding fume, the workers at this facility were exposed to high levels of inhalable PM and metal-specific welding fume components within biologically relevant size fractions.

**O01.01.06. Association between Occupational Exposure to Textile Fibre Dusts and Lung Cancer in a Population-Based Case-Control Study in Montreal: A Preliminary Analysis Comparing Results from Three Analytical Methods**

Mengting Xu

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**Abstract:** Objectives: To compare results estimated using two causal inference methods, inverse probability of exposure weighting (IPEW) and G-computation, to that estimated using the conventional multivariable logistic regression, on the association between occupational exposure to textile fibre dusts and lung cancer risk. Methods: A population-based case-control study on lung cancer was conducted from 1996 to 2001 in Montreal, Canada. Cases were individuals diagnosed with incident lung cancer and population controls were randomly selected from electoral lists and frequency-matched to cases by age, sex and electoral district. Questionnaires on lifetime occupational history, smoking and demographic characteristics were collected during in-person interview. Experts reviewed subjects' work history and assessed exposure to 294 agents, including textile fibre dusts. Odds ratios (OR) and their 95% confidence intervals (CIs) for the association between ever exposure to textile fibre dusts and lung cancer risk were estimated using three different methods: 1) IPEW, 2) G-computation, and 3) conventional multivariable regression. Results: The two causal inference methods produced higher point estimates (OR<sub>IPEW</sub>=1.17, 95% CI=0.86-1.57; OR<sub>G-computation</sub>=1.11, 95% CI=0.80-1.49) compared to that estimated using the conventional multivariable logistic regression (OR=0.87, 95% CI=0.68-1.11). However, all three sets of OR results were close to the null value. Conclusion: The different methods provided rather similar results, albeit not identical. They are compatible with a null association between occupational exposure to textile fibre dusts and lung cancer.

## **001.01.07. Chronic Obstructive Pulmonary Disease Mortality in the Diesel Exhaust in Miners Study (DEMS)**

Jacqueline Ferguson

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Abstract: Miners are routinely exposed to high levels of diesel exhaust emissions from powered equipment. Although biologically plausible, there is little evidence of elevated risk of chronic obstructive pulmonary disease (COPD) in the literature. To fill this gap, we examined COPD mortality and quantitative exposure to diesel exhaust (respirable elemental carbon (REC)) in an existing cohort of highly exposed miners with well characterized long-term exposure history. The Diesel Exhaust in Miners Study (DEMS) included 11,667 male miners who worked at least one year, on the surface or underground, in eight non-metal US mines. We fit Cox proportional hazard models to estimate hazard ratios (HRs) for COPD mortality and 15-year lagged and non-lagged REC exposure. COPD mortality was defined using ICD codes for underlying and contributing causes of death. Based on 130 cases, we categorized cumulative REC exposure into tertiles. Models were stratified by state and adjusted for respirable dust, worker location (surface and underground), race, year of hire, and calendar year, with age as the timescale. Separate models were then fit for all, underground, and surface miners. HRs for 15-year lagged cumulative REC were elevated in the middle (20-463  $\mu\text{g}/\text{m}^3\text{-yr}$ : HR 1.41 (95%CI: 0.80-2.47)) and highest (>463  $\mu\text{g}/\text{m}^3\text{-yrs}$ : HR 1.62 (0.80-3.30)) exposure categories. The HRs in underground workers were slightly stronger (78 cases). Among surface workers (52 cases), those in the highest category (>24  $\mu\text{g}/\text{m}^3\text{-yrs}$ ) had a HR of 3.46 (1.23- 9.74). HRs were attenuated when exposure was unlagged. Our results suggest that REC exposure is associated with increased risk of COPD in both underground and surface workers. The association appears stronger among surface workers, who have exposures far lower than those underground. This may suggest a steeper exposure-response at lower exposures, or the lower HR among underground miners may be due to negative confounding by smoking or healthy worker selection.

## **O01.01.08. Environmental and Biological Monitoring of Volatile Organic Chemicals among Nail Technicians**

Diana Ceballos

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**Abstract:** The U.S. nail salon industry employs 380,000 workers nationwide, many young Vietnamese women. Numerous solvents are used in nail salons, but no studies have measured personal exposure and biomarkers of nail techs. This study aims to identify key volatile organic compounds (VOCs) in nail salons; explore the relationship between personal exposure and biomarkers; and understand the occupational contribution to VOC biomarkers. Personal and area air samples were collected on 10 nail techs during a work shift in 7 nail salons in the Boston Area (2016-2017). Air samples were collected using thermal desorption tubes and analyzed for 85 VOCs. Whole blood samples were collected for each tech before and after the shift and analyzed for 45 VOCs. Ventilation rates were determined by continuous CO<sub>2</sub> measurements and a steady-state box model. We observed use of personal protective equipment (PPE). Of the VOCs detected in the air and blood samples, toluene and ethyl acetate predominated - which are common ingredients in nail products. The median and range concentrations of toluene and ethyl acetate were, respectively, 12(2-105) and 842(143-2,640)µg/m<sup>3</sup> in indoor air, 39(5-85) and 759(144-2,850)µg/m<sup>3</sup> in personal air, and 0.36(0.028-0.79) and 0.51(0.16-1.48)ng/ml in blood. Blood concentrations and personal exposures displayed moderate but insignificant associations (tol r=0.42 p=0.11; ethyl acetate r=0.43 p=0.21). Blood levels were elevated after the shift (p<0.018), indicating significant contributions from occupational exposure. Ventilation rate median and range were 25(6.4-88)cfm/person, not always meeting the 25 cfm/person guideline for nail salons. Three techs were observed using latex or nitrile gloves throughout their shift; others used latex gloves only for pedicures. Two techs were observed using disposable N95 with charcoal filter sporadically. The results suggest the need for change in nail product formulation, better ventilation, and more effective PPE to reduce exposures

S01.01A. Addressing Complex Local and Global Issues in Environmental Exposure and Health: Addressing the Health of Children and Adolescents

**S01.01.01. Early exposure to environmental pollutants and weight gain in children. Rio de Janeiro city / Brazil**

Ana Oliveira

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**Abstract:** Background/Aim: In utero and early postnatal environmental pollutants exposures, can change the metabolism, predisposing individuals to the development of chronic diseases later in life. To evaluate prenatal exposure and to test viability for a birth cohort study, a pilot study was conducted in newborns at the School Maternity of the Federal University of Rio de Janeiro (ME-UFRJ), from October 2017 until August 2018, aiming to evaluate the exposure to the following environmental pollutants: metals, pyrethroids, organochlorines and organophosphates and plasticizers to investigate exposure to environmental pollutants and weight gain in children during the first six months of life. Methodology: The study was attended by 142 pregnant from Rio de Janeiro city, with delivery at ME-UFRJ. Interviews with exposure data and measurements on maternal samples of blood, urine and hair in the third trimester of gestation were performed, and umbilical cord and urine samples were collected from the newborns. In the follow-up of infants in the first, third and sixth month, neuropsychomotor and cognitive development assessments are performed through the Denver Developmental Screening Test, anthropometric measures and breast milk and baby's urine collected. After laboratory analysis, maternal and child exposure data will be checked, and statistical tests applied. The descriptive analysis of the data will be obtained from simple frequencies, measures of central tendency and variability. Multiple analysis techniques will be used according to the outcomes and exposures, using logistic regression for binary outcomes. Expected results Changes in the developmental patterns of children at birth and up to 6 months of age, represented by impairment of weight and height growth. Conclusions: To date we do not have the laboratory results to correlate with clinical findings. However, clinical exams point in the direction of subtle changes, requiring laboratory data to associate with these findings.

**S01.01.02. Analyze Health Data of Children and Adolescents in the Municipalities with the Highest Consumption of Pesticides in the State of Sao Paulo - Brazil (2000-2015)**

Telma Nery

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Abstract: Brazil has been the largest consumer of pesticides in the world since 2008. The state of São Paulo, with 645 municipalities and a population of 44 million people stands out as a major consumer. This study presents data on health problems, according to the Ministry of Health (Datasus), of the children and adolescents of the 15 municipalities that use pesticides the most, analyzing the characteristics of pesticides used. The data used are those available at the environmental health observatory and atlases of the geography of agrochemicals in Brazil.

### **S01.01.03. Characteristics of Health and Environment in Santa Gertrudes City: Sao Paulo, Brazil**

Paolo Paz de Lima

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Abstract: City with higher levels of environmental pollution in Brazil. Presentation of the main characteristics of health and levels of air pollution in the last 10 years, considering data from the Ministry of Health and the environmental sanitation company. Reviews are made considering the health framework of children up to 15 years of age.

#### **S01.01.04. Birth Cohort Study of Environmental Exposure and Childhood Development: Rio de Janeiro / Brazil**

Carmen Asmus

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**Abstract:** This study aims to investigate alterations in childhood development associated to exposure to environmental pollutants, from pregnancy until the age of 4. Its core hypotheses are: 1) the exposure to environmental chemical pollutants determines fetus developmental alterations, birth adverse health effects, and child's neuromotor and cognitive development deficits; 2) these effects of environmental pollutants are modulated by interaction with the sociocultural environment and genetic patterns; and 3) the exposure to violence, as a chronic stressor, alters the susceptibility to the environmental chemical pollutants effects on children's health. **Methodology:** This is a prospective cohort study whose study population will be all children born at the Federal University of Rio de Janeiro Birthing Center (ME-UFRJ), from March 1st, 2019 to February 29th, 2020. All newborns will be followed for 48 months and their landmarks of physical, neurological, psychological, and cognitive development recorded. The study protocol includes interviews, physical exams, and collection of biological samples at the 7th month of pregnancy, birth, and postnatal period until the age of 4. The study will collect: 1) socioeconomic, cultural, leisure and living conditions of the parents 2) Maternal biological samples (blood, urine and hair) 3) Cord blood and urine of the newborn. The Birthing Center performs 2,000 to 2,500 deliveries/year. **Results:** From October 2017 until July 2018, a pilot study has been done. Of 209 pregnant women attended at ME-UFRJ during the period of 2 months, 142 (67,9%) accepted to participate. Until this date, there were 131 births (92.3%), and cord blood was collected from 122 births (85.9%). **Conclusion:** This study may contribute to the increase of knowledge regarding the effects of environmental pollutants exposure, and its predisposing factors or conditions, on newborn and children's health in an urban area in Brazil.

## S01.01B Air Pollution and Physical Activity: Environmental Health Perspective

### **S01.01.05. Air Pollution and Physical Activity Epidemiology: Are Long-Term Benefits of Physical Activity on Health Modified by Exposure to Air Pollution?**

Zorana Andersen

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**Abstract:** Introduction: Physical activity amplifies respiratory uptake and deposition of air pollutants in the lung, which may augment acute harmful effects of air pollution during exercise. We aimed to examine whether long-term benefits of physical activity on morbidity and mortality are moderated by long-term exposure to air pollution levels in an urban setting. Methods: 57,000 subjects (50-65 years) from the Danish Diet, Cancer, and Health cohort, were recruited in Aarhus and Copenhagen between 1993 and 1999, when they reported data on leisure-time and utilitarian physical activity. We linked the cohort to Danish nationwide registers to extract data on overall- and cause-specific mortality, incidence of asthma and chronic obstructive pulmonary disease (COPD), and incidence of myocardial infarction (MI) and stroke. We used modeled NO<sub>2</sub> levels (high/medium/low) at the residence at the cohort baseline year as proxy for air pollution exposure during physical activity. We modeled association of participation in sports, cycling, gardening, and walking with the above mentioned health outcomes by Cox regression, and introduced NO<sub>2</sub> (low/medium/high) as an interaction term. Results: Of ca. 53,000 subjects, 5,534 died until 2010, 1,151 developed asthma and 3,225 COPD until 2013, 2,936 developed MI and 4,353 stroke until 2015. Participation in sports, cycling, walking and gardening was associated with reduced risk of premature mortality (18-22%), as well as with incident asthma (15-18%), COPD (15-19%), MI (9-15%), and stroke (10-18%), and these were not modified by NO<sub>2</sub>. Conclusions: Increased exposure to air pollution during exercise in urban setting does not outweigh beneficial effects of physical activity on the risk of premature mortality, respiratory and cardiovascular morbidity.

## **S01.01.06. Air Pollution and Physical Activity (APPA): Air Pollution Exposure in Travel Modes**

Juan Orjuela

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**Abstract:** Introduction Travel microenvironments are often the most polluted places people encounter in their daily lives. Encouraging walking and cycling may increase physical activity in the population, but also lead to higher intakes of pollutants (due to high inhalations rates in highly contaminated environments). Quantification of exposure contrasts between travel modes is needed to estimate potential risks and benefits of walking/cycling. Method A systematic review of global literature comparing exposures while walking and cycling to other modes (car, bus, overground/underground rail) was conducted. Data from the disparate set of studies was harmonized to estimate ratios of concentrations in active travel vs motorized travel modes for fine particulate matter (PM<sub>2.5</sub>), ultrafine particles (UFP), black carbon (BC) and carbon monoxide (CO). Comparisons were made for ratios obtained in different continents. Results Of 280 articles examined, 27 responding to inclusion criteria were retained for analyses. Most were derived from European studies although all continents except Antarctica were represented. Globally, walking was amongst the least exposed travel modes for BC and CO, with more inconsistent results for PM<sub>2.5</sub> and UFP. Cycling was amongst the most exposed for UFP, and the least exposed for BC (other than walking). Results varied by continent. Conclusion A large variety of study designs and settings makes a unified picture of air pollution contrasts between travel modes difficult. Nevertheless the ratios and associated confidence intervals obtained provide useful metrics for health impact modelling, enabling a comprehensive analysis of risk and benefit tradeoffs of walking and cycling policies in urban environments.

### **S01.01.07. Should You Avoid Cycling and Walking in High Pollution Days?**

Marko Tainio

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**Abstract:** Background: Regular active commuting, such as cycling and walking to and from workplace, is associated with reduced all-cause mortality through increased physical activity (PA). However, active commuting may increase intake of fine particles (PM<sub>2.5</sub>), causing negative health effects. In this study we estimate the combined risk of PA and PM<sub>2.5</sub> for all-cause mortality among active commuters who, in days with high PM<sub>2.5</sub> levels work from home. Method: We modelled the changes in all-cause mortality by combining risks (exposure to PM<sub>2.5</sub> air pollution) and benefits (PA) for six cities (Helsinki, London, Sao Paulo, Warsaw, Beijing, New Delhi) using daily PM<sub>2.5</sub> concentrations as an input. In each day with PM<sub>2.5</sub> concentration above the threshold current active travellers were assumed to stay home. For threshold we used values 25 µg/m<sup>3</sup>, 50 µg/m<sup>3</sup>, 100 µg/m<sup>3</sup> and 150 µg/m<sup>3</sup> to examine which threshold value provides largest health benefits. The changes in PA and exposure to PM<sub>2.5</sub> in each city with each threshold value were estimated for three different calendar years. Results: Everyday cycling to work resulted in RRs from 0.80 (cycling) and 0.84 (walking) in Helsinki (lowest air pollution levels) to 0.86 (cycling) and 0.88 (walking) in New Delhi (highest air pollution levels). Restricting active commuting in high PM<sub>2.5</sub> days would not improve health in any examined city, but it could reduce health benefits in high air pollution cities (Beijing, New Delhi) if threshold value is below 150 µg/m<sup>3</sup>. Conclusions: Switching to working from home on in days with high air pollution would not lead to any health benefits in any examined city.

## **S01.01.08. Air Pollution, Physical Activity and Health: What Are the Pathways to Healthy Urban Living?**

Mark Nieuwenhuijsen

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*1. ISGlobal, Barcelona, Spain.*

**Abstract:** Background and aims: Many cities still suffer from high air pollution and many citizens do not do enough physical activity. Physical activity should be promoted by including it into daily lives e.g. through active commuting. Concerns have been raised about the possible risks of being physically active when air pollutions are high. The aim of this presentation is to provide a rapid update on the current status of air pollution, physical activity and health while commuting and suggests solutions to improve the current situation. Method: We conducted a rapid review of the literature on of air pollution, physical activity and health while commuting and suggestions for potential solutions. Results: The presentation will provide a brief overview of the current status on the relationship and interaction of physical activity, air pollution and urban health using a couple of examples of epidemiological and health impact assessment studies, and provide some indications for future research in the area. Initially results suggest that the benefits of physical activity well outweigh the risk of air pollution, but that under some circumstances the full benefits of physical activity are not achieved when air pollution levels are high. It will provide recommendations how to improve urban and transport planning in the light of our current knowledge to promote healthy urban living e.g. through a reduction of car use, increase in active and public transport, greening of cities or a combination of these. Conclusion: healthy urban living can be promoted through an increase in physical activity and reduction in air pollution e.g. through a reduction of car use, increase in active and public transport, greening of cities or a combination of these

## S01.01C. Air Pollution Exposure and Metabolomics

### S01.01.09. Metabolomics Profiling in Response to Air Pollution Levels

Lina Mu

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**Abstract:** Background: Metabolomics is a powerful tool in identifying metabolites and related pathways response to environmental stress, including air pollution. Epidemiological studies are limited so far. The study aims to identify metabolomics profile in response to air pollution exposure. Methods: We used 54 participants from an existing panel study in which serum from each participant was repeatedly collected before-, during-, and after- the 2008 Beijing Olympic Games when air pollution levels changed drastically. Ultra high-performance liquid chromatography/tandem accurate mass spectrometry (UPLC/MS/MS) was used in untargeted analysis. ANOVA was performed for each of the metabolites to compare their levels at three time points individually. The p-values were adjusted to control false discover rate at 0.05. Cluster analysis via graph partitioning was used to identify modules of metabolites that are regulated in a concerted manner, and investigate for over-represented pathways. Results: Totally 83 metabolites showed significant response among non-smokers after adjustment on individual metabolites analysis. Twenty modules were identified, among which the few largest modules represent pathways of fatty acids, lipid metabolism and peptides/amino-acids. Enrichment testing identified sub-pathways including Fatty Acid Metabolism (Acyl Carnitine), Gamma-glutamyl Amino Acid, Methionine, Cysteine, SAM and Taurine Metabolism, Glutathione Metabolism, Eicosanoid, Fatty Acid, Amino, Purine Metabolism, (Hypo)Xanthine/ Inosine containing, Leucine, Isoleucine and Valine Metabolism. Among smokers, 142 metabolites showed significant response to the changes of air pollution level, with larger observed changes than non-smokers. Module analysis suggested very similar pathways to that among non-smokers. Conclusion: Both smokers and non-smokers showed significant response to the changes in air pollution levels, especially in the pathways of fatty acids, lipid metabolism and peptides/amino-acids.

## **S01.01.10. Non-Targeted Metabolite Profiling of Dried Blood Spots in a Field-Based Epidemiologic Study of Household Air Pollution**

Maggie Clark

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Abstract: Household air pollution (HAP), primarily from solid fuel combustion in cookstoves, is a leading risk factor for the global burden of disease; however, direct evidence linking HAP with chronic disease endpoints is limited. Obtaining clinical chronic disease measures in rural settings of low- and middle-income countries is logistically challenging; consequently, focus has been placed on subclinical indicators of risk. The ability to conduct non-targeted metabolomics profiling from dried blood spots (DBS) represents an innovative approach with potential for biomarker discovery and characterization. We conducted a cross-sectional study among 107 women, aged 25-55 years, using wood-burning cookstoves in rural Honduras. Kitchen and personal 24-hour fine particulate matter (PM<sub>2.5</sub>) concentrations were collected via gravimetric sampling. DBS were collected via finger-stick. Global non-targeted metabolite profiling was performed using reverse phase ultra performance liquid chromatography and high resolution mass spectrometry. In separate linear models, we evaluated the association between 24-hour PM<sub>2.5</sub> concentration and each metabolite, adjusting for age, body mass index, physical activity, and socio-economic status, using a correction for multiple testing. PM<sub>2.5</sub> exposures were associated with 27 out of 1,395 metabolites; five metabolites were annotated (e.g., phenylalanine, terpene). Lysophosphatidylcholine 18:2, a metabolite previously identified as being protective for incident coronary heart disease, was inversely associated with kitchen PM<sub>2.5</sub> concentrations. We will evaluate standards for annotated metabolites to quantify the PM<sub>2.5</sub> relationships. The use of DBS could have far-reaching impacts on field-based sciences, such as HAP research, by expanding the ability to characterize environmental impacts on metabolomic profiles in rural populations where relevant measurements were previously not feasible.

### **S01.01.11. Ambient Air Pollution Exposure Is Changing Metabolomics Profiles: A Link to Disease Development**

Cavin Ward-Caviness

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Abstract: Metabolomics offers an unbiased approach to characterize the metabolism and organ cross talk based on serum or plasma samples. It is potentially able to demonstrate systemic impacts of environmental exposures such as ambient air pollution beyond the lung. The presentation will discuss analyses linking ambient air pollution to changes in metabolomics profiles. It will consider both short-term and long-term exposures to ambient air pollution. It will further discuss the need for additional data analyses tools to capture fully the potential of the high-dimensional data. It will consider the challenges associated with measurement errors and intra-individual variability. Finally, the potential to unravel pathways linking ambient air pollution to the development and exacerbation of disease will be discussed.

## **S01.01.12. Module Detection in Attributed Networks for the Association with Outcomes**

Rachael Blair

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Abstract: Networks are widely used to model associations, direct and indirect relationships between a complex set of variables. Mining networks for modules/clusters of nodes (e.g., patients or samples) is an open and challenging problem. This problem is referred to as module (community) detection. The majority of approaches to the rely solely on the network structure. However, in biological networks, it is often the case that the nodes in a network have attributes (aka metadata) associated with them. Utilizing attribute information for the detection of communities is important to fully leverage the data but requires bridging the structural network with attribute data. In this talk, I will introduce the module detection problem in networks with complex attributes, and how to link these modules with outcome variables (e.g., exposure or survival) for prioritization. A novel method the Weighted Fast Greedy (WFG) algorithm will be introduced for attribute-based community detection that addresses this challenge in a scalable manner. WFG leverages logistic regression modeling and is used to bridge the structural and attribute spaces by regressing vectorized attribute similarities on the structural data. In this setting, weights are estimated that naturally emphasize (or dampen) attributes that associate with structure. WFG couples these weights with an existing fast greedy algorithm designed for large networks. The model also allows for mixed attributes and enables the prioritization of inferred modules through coefficient ranking, which directly captures attribute homogeneity. WFG shows good performance over a range of simulations for networks with varying levels of structure, in networks with missing links, and in networks where the community sizes are severely unbalanced. Examples will be presented that highlight applications in proteomics, metabolomics and transcriptomics.

## S01.01D. Bronchiolar and Interstitial Lung Disease by Occupational and Environmental Exposure: Their Implication and Future Task to Be Solved for Health Protection

### **S01.01.13. Outbreaks of Severe Lung Injury Caused by Agents that Were Deemed Safe: From Air-Sprayed Paints to Humidifier Disinfectants**

Benoit Nemery

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Abstract: In 1992, outbreaks of severe organizing pneumonia occurred in Spain among textile workers who had been air-spraying supposedly non-toxic paints (Moya et al. Lancet 1994, 344, 498-502; Romero et al. Eur Respir J 1998, 11, 265-71). The disease was named "Ardystil syndrome" after the factory where most casualties occurred. A smaller outbreak was caused by the same products in Algeria (Ould Kadi et al. Lancet 1994, 343, 962-3; Eur Respir J 1999, 13, 940-1). Experimental studies in vivo and in vitro demonstrated that the incriminated paints (Acramin FWR and Acramin FWN) were highly toxic for the respiratory tract (Clottens et al. Occup Environ Med 1997, 54, 376-87; Hoet et al. Toxicol Sci 1999, 52, 209-216), probably on account of their polycationic character (Hoet et al. Toxicol Appl Pharmacol 2001, 175, 184-190). The outbreaks of severe interstitial lung disease that occurred during spring among children and adults in South Korea between 2006 and 2011 were attributed to disinfectants added to domestic humidifier systems. The biocide that has been most consistently associated with the disease is polyhexamethyleneguanidine (PHMG), a polycationic agent of low oral or dermal toxicity, with structural similarity to the polycationic paints that caused the Ardystil syndrome (Nemery and Hoet. Am J Respir Crit Care Med 2015, 191, 116-7). PHMG eventually also proved to exhibit high respiratory toxicity in experimental animals and in vitro test systems. Several other examples exist of serious respiratory disease caused by chronic inhalation of supposedly safe agents (butter flavour, nylon microfibres) for which toxicity by inhalation was only demonstrated experimentally many years after epidemiological studies had shown that they could cause lung injury in humans. Potentially inhaled agents must be deemed hazardous until proven innocent.

#### **S01.01.14. Bronchiolar and Interstitial Lung Disease by Humidifier Disinfectant Syndrome in Korea**

Jong Han Leem

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Abstract: The outbreaks of severe interstitial lung disease that occurred during spring among children and adults in South Korea between 1994 and 2011 were attributed to disinfectants such as polyhexamethyleneguanidine (PHMG), added to domestic humidifier systems. Several papers reported that these interstitial lung diseases have the following characteristics: nonsuppurative necrotizing and obliterative bronchiolitis with various stages of peribronchiolar organizing alveolar damage, Relative sparing of subpleural and paraseptal parenchyma. But following studies showed many other interstitial pneumonitis are also associated with the exposure of humidifier disinfectants by big data analysis. Our studies showed that there are clear dose-response relationships between many other interstitial pneumonitis and the exposure of humidifier disinfectants in humidifier disinfectants victims and some general groups. Different exposure patterns and underlying diseases made diverse types of bronchiolar and interstitial lung disease. What is toxicologic mechanism of humidifier disinfectants? ROS (Reactive Oxygen Species), decreased T cell and pro-inflammatory cytokine release from macrophage could raise the possibilities of causing interstitial fibrosis, asthma and many other diseases. . All adverse health effects byhumidifier disinfectants can be called as humidifier disinfectants syndrome. Our survey also showed that the magnitude potential victims with adverse effects from humidifier disinfectants are from two million to 0.4 million. We only found the tip of an iceberg about the humidifier disinfectants syndrome. We can explore the real adverse outcomes by epidemiologic study using big data such as National Health Insurance Data and toxicologic studies. Toxicokinetic studies will support the results of toxicologic studies such as in-vitro, in vivo, adverse outcome pathways (AOPs) studies.

### **S01.01.15. Health Damage of Humidifier Disinfectant by Big Data Analysis in Korea**

Hae-Kwan Cheong

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Abstract: The accident of humidifier disinfectants found in 2011 was one of the biggest man-made environmental disaster in South Korea. It was estimated that at least 5 million people was exposed and 5 hundreds of thousands people experienced health problems. However, the governmental countermeasures focused mainly on the differential diagnosis and compensations for the voluntary registered victims of 6,000 people. So, the epidemiologic studies to uncover the size of health problems were insufficient. We tried to estimate the correlation between humidifier disinfectants consumption with some target diseases (interstitial pulmonary diseases, asthma, etc.) in South Korea using the National Health Insurance Research Database Study. Claims data of 50 million people over 15 years (January 2002~September 2017) were reconstructed to extract episodes of care with target diseases diagnosis including residence district and SES. Relative risk estimates from age-period-cohort and difference in difference analysis were compared with humidifier disinfectant consumptions (1994~2011). In 282,114 interstitial pulmonary diseases patients, correlation coefficients between relative risk estimates of 'period effect' and humidifier disinfectant consumption were 0.942 in male and 0.930 in female with 1 year latent period assumption. Correlation coefficients between relative risk estimates of 'cohort effect' and humidifier disinfectant consumption were 0.854 in male and 0.797 in female. And, we found a specific rise and fall pattern among 2003~2011 birth cohorts. We could find high correlation and specific rise & fall patterns of health care episodes with humidifier disinfectant consumption using national total population cohort data. These kinds of big data system can make relatively objective epidemiologic evidences for environmental health problems.

### **S01.01.16. Characteristics of Exposure to Humidifier Disinfectant (HD) among Patients with Lung Injury**

Dong-Uk Park

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Abstract: Since around the year 2000, hundreds of people in Korea have developed humidifier disinfectant associated lung injury (HDLI). We evaluated the association of HD use with LI among the 1,199 people who had registered with the Humidifier-associated with Lung Injury Investigation and Decision Committee (HLI IDC) up to the third round. Through clinical examinations by a team consisting of pediatric pulmonologists, radiologists, and pathologists, the level of association of lung injury with the use of HD was sorted into definite, probable, possible, and unlikely. Lung injury patients with an association with the use of HD ranked as possible and higher were all categorized as HDLI patient groups. Among the registered people, 38% (1st round=214, 2nd =73, 3rd=166) were confirmed as HDLI patients. Children aged under eight years old made up the highest proportion of HDLI cases (n=279, 62%), followed by pregnant women (n=31, 7%). One hundred thirty (29%) of the HDLI patients died. Fifty-seven percent of HDLI patients (n=259) developed HDLI after less than one year of HD use. The number of HDLI patients who used only the Oxy Saksak HD brand was found to be 176 (39%), followed by the brands Cefu (n=27, 6%). HD products containing only PHMG were the most frequently used among HDLI patients (n= 234, 52%), followed by PGH (n=27, 6%) and a mixture of CMIT and MIT (n=26, 6%). In conclusion, the development of HDLI was evaluated to be associated with the use of 11 HD products containing PHMG, PGH, and CMIT/MIT.

## S01.01E. Climate, Air Pollution, and Environmental Health in Africa 1

### S01.01.17. Short Term Seasonal Effect of Ambient Air Pollutants and Airborne Fungal Spores on the Lung Function of School Children in Western Cape, South Africa: A Panel Study

Toyib Olaniyan

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**Abstract:** Background: Only 3 previous epidemiological studies have investigated the combined effect of short-term ambient air pollutants and fungal spores on individual level children's lung function. These studies did not investigate respiratory effects beyond 1-day lag nor investigated interaction effects. We aimed at investigating the combined effect of short-term air pollutant and fungal spore exposure on individual level lung function of school children. Methods: A panel study was conducted incorporating testing for 2 consecutive school-weeks each in summer and winter on 553 grade-4 school children from 4 informal settlements in the Western Cape Province of South Africa. Outcomes were measured using peak flow meters obtained 3-times daily concurrently at all schools. Daily PM10 levels was available from a stationary monitor near 2 of the study areas, while daily levels of fungal spores was measured using spore traps in all 4 study areas throughout the year. The effects were analysed using single- and multi-pollutant distributed lag linear and non-linear model for lags up to 5-days. Results: Daily *Alternaria* and *Cladosporium* was significantly associated with FEV1 deficit and increased PEF intraday variability, especially in winter. The strongest adverse effect was on FEV1 (-369.34 ml, 95% CI: -650 to -87.77 ml) resulting from an overall cumulative increase of 50 spores/m<sup>3</sup> in *Cladosporium* from lag day-0 through lag day-5. There was significant interaction between PM10 and *Alternaria* on reduced FEV1 ( $p < 0.001$ ) and increased intraday-variability in PEF ( $p < 0.001$ ), including PM10 - *Cladosporium* interaction on increased intraday variability in PEF ( $p < 0.01$ ), all during winter. Conclusion: The study provides evidence that daily exposure to ambient fungal spores, *Alternaria* and *Cladosporium* results in lung function deficits especially in winter. The adverse effect on lung function by the fungal spores can occur beyond the day of exposure and is modified by ambient PM10 exposure.

## **S01.01.18. Closing Research Gap on Climate Change and Health in Africa**

Adetoun Mustapha

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Abstract: The effects of climate change are felt in many parts of Africa with the alteration of intensity and seasonal nature of the rains; elevation of average annual temperatures; and increased frequency of high impact weather phenomena including drought and flooding. The resulting health risks will particularly affect vulnerable and poorly resourced populations. A review of literature was conducted on Google Scholar to explore research available on awareness of climate change among populations that depends on climate sensitive resources for livelihood in Africa and effectiveness of adaptive measures on public health at regional level. The search was carried out on 28 March 2018 and limited to articles that were published in English Language since 2008. Additionally, the reference lists of relevant articles were manually checked. Some 20,100 records were retrieved, out of which 120 full papers were assessed and 21 reviewed. The number of published literature retrieved for the whole of the African continent is about the same for developed countries like United Kingdom and United States of America. There were more studies on vulnerability assessments of natural environment than awareness of climate change by socioeconomically disadvantaged populations and effectiveness of adaptive interventions on public health. Research are primarily being driven by international institutions, national governments, NGOs and were mainly from those nations receiving adaptation funds. There is minimal involvement of lower levels of government and local academic institutions or collaboration across nations or African professionals. Gaps in knowledge of effective local adaptation actions and adaptation policy are particularly notable. Future research needs to address these gaps through regional collaboration and involvement of local institutions and network of African researchers to be able to promote proactive adaptation actions that is beneficial to public health at regional level.

## **S01.01.19. No More Disciplinary Silos in Tackling Climate Change Impact on Health: Lessons from an Ecohealth Research Project in West Africa**

Brama Kone

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Abstract: Vector-borne diseases contribute significantly to the burden of disease in Africa and climate changes is adding new pressures. However, the complex impacts in terms of related hazards, vulnerabilities and exposure are not adequately understood. We used an Ecohealth research methodology to develop community-based interventions against malaria and schistosomiasis in Korhogo and Kaédi, two west African cities. We collected field data during rainy and dry season on each site by cross-sectional surveys: household questionnaire and parasitological surveys, entomological, malacological and geographical survey. In addition, weather and climate data have been generated. In Korhogo, malaria prevalence was 17 % (583/3422) and 8,1% (280/3446) during rainy and dry seasons respectively, while 0,07% (3/4297) and 0,6% (23/3863) during the same seasons in Kaédi. An increment in rainfall of 1 Cm during two month before was on average associated with a 1.0% (95%-CI: 0.4% to 1.6%) increase in malaria incidence in Korhogo. Anopheles larvae were 19,44% (3803/19560) and 0,3% (4/1056) of all larvae collected respectively in Korhogo and Kaedi. Dissolved oxygen (OR =1.20; p=0.029), Conductivity (OR =0.99; p=0.003) and Turbidity (OR = 0.99 ; p=0.007) have strong correlations with presence of Anopheles larvae in water bodies. Urinary schistosomiasis was more prevalent in Kaédi 3,44% (88/2554) than in Korhogo (0,4% (9/2373)) while Intestinal schistosomiasis was mainly observed in Korhogo (4,6% (102/2211)). Three snail species were collected in each site: *Bulinus truncatus*, and *B. forskalii* in both, *B. senegalensis* in Korhogo and *Biomphalaria pfeifferi* in Kaédi. There is a strong propensity to self-medication by the use of traditional plants. People practiced a care syncretism for malaria while for schistosomiasis, they mainly use local traditional strategies. Results were presented to all stakeholders and community-based interventions were implemented to face the two diseases.

## **S01.01.20. Evaluating the Effectiveness of a Community-Based Adaptation Strategy for Dengue Vector Control in Burkina Faso**

Tarik Benmarhnia

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**Abstract:** Dengue outbreaks have occurred in several sub-Saharan African countries since 2010 and are expected to increase in the context of climate change. The success of efforts for prevention and control of dengue relies on the effectiveness of initiatives related to control of *Aedes* mosquito breeding sites, improving population mobilization, engagement knowledge, and improving household environmental sanitation, through sustained modification of human behavior. We developed and implemented an experiment for dengue vector control in Ouagadougou, the capital of Burkina Faso. Households in the intervention (n=287) and control (n=289) neighborhoods were randomly sampled and the outcomes collected before the intervention (October 2015) and afterwards (October 2016). The primary outcomes included: blood samples from residents to evaluate their exposure to *Aedes aegypti* (DV) bites and the density of pre-imaginal stages of the vector in water-holding containers. Data analysis included propensity score stratification approaches. The intervention reduced residents' exposure to DV bites (vector saliva biomarker difference= -0.08, 95% CI=-0.11; -0.04). The pupae index, a key entomological indicator for adult mosquitoes, declined in the intervention neighborhood (from 162.14 to 99.03) while it increased in the control (218.72 to 255.67). Well-planned, evidence-based community-based adaptation strategy for dengue vector control are feasible in West African urban settings and can be effective in controlling and reducing exposure to DV.

## S01.01F Complex Rural Exposures and Health

### **S01.01.21. Assessment of Exposure and Health Outcomes in Rural Settings**

Meghan Davis

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Abstract: Exposures to toxicants and infectious agents in rural settings often differ from those in urbanized areas, and the link between these complex exposures and health outcomes has been given less attention at both the research and the regulatory levels. The goals of this presentation, which will introduce and provide an overview of the "Complex Rural Exposures and Health" symposium, are to offer examples of why linkage of exposure and health in rural settings is important, discuss emergent tools and approaches for measurement of exposure, examine the challenges of both exposure and health outcome assessment in these settings, and discuss how interdisciplinary and multi-institutional efforts can be used to overcome these challenges. Examples will focus on measurement of biological exposures (pathogens, microbiome, allergens) and gases (ammonia, hydrogen sulfide). Quantitative (epidemiologic) methods, qualitative methods and One Health approaches will be offered. Engagement of stakeholders will be emphasized. Through this presentation, the symposium organizers will provide the unifying principles for the symposium and introduce formal methods that catalyze or support interdisciplinary approaches to link exposure assessment and health outcomes in rural settings.

## **S01.01.22. Object Based Image Analysis (OBIA) Methods for Mapping Poultry Farm Locations**

Beth Feingold

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**Abstract:** Background: Livestock production is a major industry in the United States. Though livestock farms are associated with community exposures to pathogens and environmental pollutants, conducting exposure assessments and epidemiological analyses are often hindered by the difficulty of ascertaining their geographic locations. While county and watershed level counts of animal operations are available through the US Department of Agriculture's Agricultural Census, a publicly available dataset of livestock farm locations does not exist. Objective: The presentation will explore a novel method employing object based image analysis (OBIA) to map farm locations, highlighting a case study of poultry farms in the state of Delaware (DE), USA. Methods: Briefly, a rule-based expert system to identify poultry houses was designed in eCognition Developer and deployed using eCognition Server (Trimble, Inc. Westminster, CO) that employs OBIA techniques to conduct a feature extraction of poultry farms from a combination of high-resolution imagery, LIDAR (light detection and ranging), and ancillary vector datasets, yielding a proposed geospatial database of poultry farm locations. Results were imported into ArcGIS (ESRI Corp, Redlands, CA) for subsequent analysis. Accuracy of poultry operation locations was assessed visually and in comparison to an animal operation facilities dataset from the DE's publicly available land use / land cover dataset and the Delaware Environmental Navigator. Results: Producer's accuracy for identifying poultry farms was 90%. While user's accuracy was 50%, this was improved significantly by utilizing ancillary datasets. 3% of operations identified as poultry operations were non-poultry animal operations. Conclusion: Object based image analysis, especially when used in conjunction with ancillary data, is a promising tool for mapping poultry operations. Further study is needed to determine its generalizability to other animal operation types and geographic areas.

### **S01.01.23. Electronic Health Records for Population Health Research in Rural Communities**

Joan Casey

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Abstract: Most healthcare systems now use electronic health records (EHRs) to catalog clinical care and track patient health over time. EHR-derived data offers a unique and particularly useful resource for epidemiologists to study populations and individuals distributed across a range of environments. In contrast to classic cohort studies, usually deployed from urban centers, EHR databases provide a low-cost means of accessing rich longitudinal data on diverse populations in rural communities. Access to this data has allowed researchers to evaluate research questions of importance to rural communities, including potential associations between high-density livestock production and unconventional natural gas development and population health. Patient health data from Geisinger in Pennsylvania previously revealed associations between high-density poultry production and *Campylobacter* diarrheal infection and unconventional natural gas development and preterm birth. In fact, when stratifying analyses by community type (i.e., rural, suburban, and urban), associations between high-density poultry production and *Campylobacter* diarrheal infection strengthened. Using these two prior studies as scaffolding, this talk will provide an overview of the content and accessibility of EHR data. It will cover source population identification, cohort assembly, exposure assessment, how to extract health and social data from the EHR, and how to link these data with publicly-available data outside the EHR to better understand diseases in rural U.S. communities.

## **S01.01.24. Implementation of a Panel Exposure and Health Study in a Rural Setting**

Meredith McCormack

*Meredith McCormack<sup>1</sup>, Kirsten Koehler<sup>1</sup>, Nadia Hansel<sup>1</sup>, Phillip Scheuerman<sup>2</sup>, Ying Li<sup>2</sup>, Mildred Maisonet<sup>2</sup>*

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Abstract: Drivers of environmental health disparities may differ between urban, suburban, and rural regions. The CURE COPD Program focuses on environmental determinants of COPD with a goal of identifying approaches to reduce harmful exposures and improve health among those living in poverty with COPD in rural and urban settings. The CURE COPD Appalachia project is a collaboration between East Tennessee State University and Johns Hopkins University. Through this partnership, we have designed and implemented a longitudinal study focused on identifying sources of indoor air pollution and measuring the impact of exposure on respiratory morbidity in COPD. The study includes detailed home inspection and continuous air monitoring for one week at baseline, 3, and 6 months with simultaneous assessment of respiratory health outcomes. The successful implementation of this study has required that we address challenges through community engagement, intensive training of study staff, frequent communication between study teams, and with the assistance of community based champions of the project. We discuss lessons learned through our partnership and the conduct of this longitudinal environmental cohort study.

## S01.01G. Evaluating High-Throughput New Approach Methods (NAM) for Exposure

### S01.01.25. Evaluation of High-Throughput Chemical Functional Use Models

Katherine Phillips

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Abstract: The United States Environmental Protection Agency's Office of Research and Development has generated high-throughput quantitative structure-use relationship (QSUR) models that predict the probability of a chemical fulfilling a specific functional use in consumer products and chemical processes, through knowledge of that chemical's structure. Identification of a chemical's functional use provides clues to both its expected concentration and the intentionality of its presence in a product. Information on the presence or amount of chemicals in products can be used as inputs to exposure models but is often lacking. For these data-poor chemicals, predictions of functional use can be used to parameterize high-throughput exposure models and support rapid prioritization of chemicals for risk and alternatives assessments. The QSUR models were built using a training set of functional use data derived primarily from the consumer product sector. Publicly available functional uses reported for chemicals in the industrial sector by manufacturers under the Chemical Data Reporting (CDR) Rule of the Toxic Substances Control Act were used to evaluate the QSUR model predictions for industrial chemicals. A total of 5153 chemicals in CDR had reported functional uses that could be compared to QSUR predictions. Only 2689 of these are single compounds with a definite, disclosed structure. Of those 2689, 1603 had predictions with a high probability ( $\geq 80\%$ ) of having a functional use and were within a model's domain of applicability. In addition, sector information (industrial or consumer) reported in the CDR was used to explore structural differences in chemicals having the same function in different sectors showing that chemicals with certain functional uses (solvents, preservatives) can differ drastically in structure from one sector to another, while others (emulsifiers, surfactants) can have similar structures in both sectors. This abstract does not necessarily reflect US EPA policy.

## **S01.01.26. Comparison of High-Throughput Exposure Predictions to Traditional Exposure Assessments under Canada's Chemicals Management Plan**

Angelika Zidek

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Abstract: Under Canada's Chemicals Management Plan, over 3000 substances have been assessed and concluded on under the Canadian Environmental Protection Act (1999). As part of these conclusions, hundreds of assessments have been published over the last 10 years. These assessments include quantitative exposure estimates for the general population from a wide range of sources such as food, indoor and outdoor air, water, soil, dust as well as products available to consumers (e.g. cosmetics, textiles, paints, cleaners, toys). This presentation will compare results from high-throughput exposure models with exposure estimates from recently completed assessments under Canada's Chemical Management Plan. High-throughput exposure models such as SHEDS-HT will be compared to exposure estimates generated using 'traditional' exposure tools as well as available environmental monitoring and human biomonitoring data. The role of route as well as duration of exposure will also be discussed. This presentation will also look at drivers of exposure and risk, including the role of near and far-field exposures, as well as the relationship between types of product uses, and reported volumes for both human health risk assessment and chemical priority setting.

## **S01.01.27. Evaluating NAMs for Toxicokinetics**

John Wambaugh

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Abstract: Toxicokinetics (TK) is required information for chemical risk assessment. Unfortunately, TK data are not available for most chemicals in commerce and the environment. New approach methodologies (NAMs) have been developed to predict time course concentrations in relevant tissues or plasma based upon in vitro experimental data and physico-chemical properties. These high throughput TK (HTTK) data and models are made freely available through an add-on ("httk") to the free statistical software R as well as through the US EPA CompTox Chemistry Dashboard (<http://comptox.epa.gov>). Using HTTK, data from high throughput screening projects such as Tox21 and ToxCast can be compared to exposure estimates to generate risk-based prioritizations. HTTK NAMs are being evaluated through 1) uncertainty analysis and 2) comparison between in vitro predictions and in vivo measurements of both plasma concentrations and doses associated with the onset of effects (i.e., "points of departure"). Bayesian methods allow chemical-specific uncertainty estimates for in vitro TK data. Monte Carlo simulation can propagate both measurement uncertainty and biological variability into risk predictions, indicating that for most chemicals, variability contributes substantially more than uncertainty. Comparisons between in vitro predictions and in vivo observations have relied on two approaches: comparison between HTTK predicted time course concentrations in plasma and in vivo data indicate that some properties (e.g. average and maximum concentration) can be predicted with confidence. Second, comparison between in vitro bioactivity data and HTTK-adjusted internal dose predictions for in vivo points of departure has refined assumptions of the HTTK NAMs. NAMs for TK could allow risk-based prioritization of large numbers of chemicals. The views expressed here are those of the authors and do not necessarily reflect the views or policies of the U. S. EPA

## **S01.01.28. Evaluation of High-Throughput Chemical Exposure Models: Case Study of Matched Environmental and Biological Measurements**

Kristin Isaacs

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Abstract: U.S. EPA, under its ExpoCast program, is developing high-throughput near-field modeling methods to estimate chemical exposure and to provide real-world context to high-throughput screening (HTS) data. These novel modeling methods include reverse methods, which infer parent chemical exposures from biomonitoring measurements, and forward models to predict multi-pathway exposures from chemical use information and/or residential media concentrations. Both modeling methods were used to characterize the relationship between near-field environmental and biomarker measurements. Indoor air, house dust, and urine samples of 120 females (aged 60 to 80 years) were analyzed. In the measured data, 78% of the residential media measurements and 54% of the urine measurements were below the limit of quantification. Due to the degree of censoring in both air and dust data, we applied a latent variable estimation approach based on an expected relationship between air and dust concentrations. Using the partitioning model of Weschler and Nazaroff (Atmos. Env., 2010) and assumptions about the variance in concentrations within homes, we jointly estimated chemical-specific geometric mean air and dust concentrations from the observed measurements. This resulted in 14 chemicals with matched air, dust, and urine metabolite data. The indoor air and dust concentrations were compared to population median exposures inferred from urine metabolite concentrations using a reverse-dosimetry approach. Median air and dust concentrations were found to be correlated with inferred exposures; forward model predictions were used to characterize pathway contributions to aggregate exposures. These results demonstrate that the forward and reverse methods being developed in ExpoCast can predict intake amounts and routes of exposure, and that these models can also identify exposure pathways that contribute to biomarker concentrations in the general population. This abstract does not reflect EPA policy.

## S01.01H. Harmonization of Biomonitoring Measurements: Approaches Used by Laboratory Networks in Canada, Europe and the United States

### **S01.01.29. Harmonization of Biomonitoring Measurements in the Canadian Health Measures Survey: An Overview of Approaches, Challenges, and Successes**

Annie St-Amand

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**Abstract:** The generation of high-quality biomonitoring data is essential for human exposure assessment and health effects research. The Canadian Health Measures Survey (CHMS) is the most comprehensive, direct health measures survey conducted in Canada and includes a biomonitoring component to measure exposure to environmental chemicals. Since its initiation in 2007, the program has successfully measured more than 250 chemicals in the blood, urine, and hair of Canadians. CHMS biomonitoring data have been used to establish baseline human biomonitoring concentrations in Canadians, inform public health, regulatory risk assessment and management decisions, and fulfill national and international chemical reporting requirements. These achievements required efforts to harmonize this program with other national and international programs on various areas of biomonitoring. This study provides an overview of the harmonization approaches in different practical aspects of the Canadian national biomonitoring program, including chemical selection, laboratory implementation and coordination (including method development, validation, and QA/QC processes), and data reporting (including LOD/LOQ and report format). Harmonization of approaches in Canada's program ensures consistency across programs, comparability of data from one cycle to the next and with other populations, and enables tracking of exposure over time. Continued coordination of approaches will provide opportunities for the development of a biomonitoring network to enhance collaboration and cooperation among national and international biomonitoring programs.

### **S01.01.30. Harmonization of Human Biomonitoring and Untargeted Exposure Analysis in Children's Health**

David Balshaw

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Abstract: The NIEHS Children's Health Exposure Analysis Resource (CHEAR; <https://chearprogram.org/>) is a network of laboratories and a data analysis center providing harmonized analysis of environmental exposures in NIH studies focused on children's health. The Consortium provides three layers of analyses; traditional, hypothesis driven, biomonitoring; untargeted, discovery driven, Exposomics, and mechanistic anchoring through biological response indicator profiling. In an effort to ensure the highest quality of analyses and greatest comparability between laboratories CHEAR has implemented a hierarchy of strategies to standardize and harmonize the analyses. These include internal and external proficiency testing, common quality assurance standards and randomization schemes which will be discussed in detail. CHEAR has also undertaken a cross validation of targeted and untargeted methods to assess the reliability of untargeted methods as a tool for exposure assessment.

**S01.01.31. Harmonization of Human Biomonitoring Measurements in the National Biomonitoring Network (United States): Learning from the Experiences of Others**

Julianne Nassif

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Abstract: The assessment of community environmental exposures, evaluation of public health interventions and the development of effective environmental health policy are all reliant on high quality biomonitoring data. The newly formed National Biomonitoring Network (NBN) aims to harmonize biomonitoring measurements determined in local, state and federal government laboratories with the goal of data comparability and sharing to inform public health practice. The NBN is a performance based network affording flexibility in the use of analytical methods and platforms but increasing the need for robust quality management programs and demonstrations of technical proficiency. By researching the approaches to measurement harmonization used in other biomonitoring networks and assessing the strengths and challenges presented by each, the NBN Steering Committee will refine the harmonization protocols developed for study design, specimen collection, analytical testing, data analysis and data management.

## **S01.01.32. Harmonization of Human Biomonitoring in Europe: The European Human Biomonitoring Initiative HBM4EU**

Marike Kolossa-Gehring

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Abstract: HBM4EU follows an innovative approach to generate the knowledge policy makers need to improve policy in the field of environment and health. Successful chemical policy also relies on sound human biomonitoring data. At the European level data from different countries must be comparable between countries to be used for regulatory purposes at EU level and for elucidating potential regional differences. HBM4EU consists of 109 partner organisations from 28 countries -27 European countries plus Israel - and is organised around 16 work packages led by key players of national HBM studies and research programmes. Major fields of activities are the science policy transfer, Human Biomonitoring (HBM) studies, and research to elucidate the impact of exposure on health. HBM reveals extent and quality of multiple chemicals exposures. Harmonisation is needed at all phases of HBM studies: e.g. study design, data protection and ethical issues, study information materials, informed consent, field work, selection of appropriate biomarkers and matrices, comparability of chemical analysis, QA/QC programs, mixtures, novel biomarkers and screening approaches, sample storage and transport and data analysis. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733032.

## S01.01I. Mobilizing Data for Healthy Environments: Platforms Facilitating Health and Environmental Exposure Linkage

### S01.01.33. Enhancing Environmental Data Resources in Cohort Studies: ALSPAC Exemplar (ERICA)

Andy Boyd

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**Abstract:** Introduction Novel platforms are needed to link spatially determined environmental data with longitudinal population study data. However, the relationship between spatial data and disclosure risk raises confidentiality concerns that need addressing. Methods Within the Avon Longitudinal Study of Parents And Children (ALSPAC) birth cohort, we aimed to establish generalisable mechanisms for spatial linkage using a 'Data Safe Haven' framework (Burton et al. 2015). Technical processes (e.g. geocoding participants' address records, developing an 'engine' for linking to exposure data) were tested for acceptability with participant advisors in focus-groups and tuned to meet regulatory requirements (e.g. ISO27001 security accreditation). We are applying this in an exemplar investigation assessing in utero NO<sub>2</sub> exposure with later childhood respiratory outcomes. Results Participants' viewed location based research as acceptable, but expressed clear expectations that location data processing should be restricted to trusted study staff. Concerns were raised regarding GPS location tracing data. This necessitates a 'split stage' protocol, where personal identifiers are handled separately from exposure data and epidemiological analysis. Daily NO<sub>2</sub> exposure from pregnancy onwards was estimated from modeled concentrations using an ensemble approach and validated using contemporaneous sensors. Participants' location data was geocoded and linked to NO<sub>2</sub> at spatial locations using the new open source ALGAE privacy-preserving geocoding engine; creating a lifetime residential and exposure history for study participants. Conclusions Participants expect that confidentiality risks introduced by spatial research are controlled. Software tools with aligned governance controls can facilitate linkage of spatial environmental data in large cohorts, to support large-scale epidemiological studies of environmental exposures.

### **S01.01.34. The Canadian Urban Environmental Health Research Consortium (CANUE)**

Dany Doiron

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Abstract: CANUE is a Canadian Institutes of Health Research-funded platform for supporting environmental health research. CANUE collates and generates standardized environmental data on air and noise pollution, land use, green/natural spaces, climate change/extreme weather, and socioeconomic conditions for every postal code in Canada and makes them freely available to researchers. A dozen national exposure databases and related metadata files are now available through CANUE, and new regional and national datasets are regularly added to a central database. Streamlined processes for data sharing and integration have been developed to facilitate easy merging with existing observational cohorts and administrative health databases from across Canada. Substantial consultation has also taken place with a wide range of health data holders to establish appropriate processes for receiving and managing environmental data, with particular focus on addressing challenges presented by differing ethics, consent and confidentiality requirements. The CANUE collaborative model illustrates how the scientific potential and cost-effectiveness of environmental health research can be improved through better coordination among researchers and data holders. Processes facilitating the merging of area-level environmental exposure datasets with some of Canada's largest cohort and health databases help accelerate the research process by making analysis-ready data available to investigators, create unprecedented opportunities to study how multiple environmental factors are linked to a wide range of health outcomes, and generally increase the use of health and population databases for environmental health research.

### **S01.01.35. Harmonisation of Air Pollution Exposures in the European ELAPSE Study**

Kees de Hoogh

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Abstract: Epidemiological cohort studies have consistently found associations between long-term exposure to outdoor air pollution and adverse health effects. However, uncertainty about the shape of the concentration response function exists at low concentrations. Effects of Low-Level Air Pollution: A Study in Europe (ELAPSE) is a Europe-wide multi-centre collaboration addressing the issue of health effects at low air pollution. Fine scale hybrid LUR models, for PM<sub>2.5</sub>, NO<sub>2</sub>, Black Carbon and O<sub>3</sub> were developed incorporating land use and traffic data plus satellite observations and dispersion model estimates as additional predictor variables. Models were applied to 100x100m grids across Europe and transferred to each cohort, and linked to participants on the basis of address-level geocodes. Strict protocols were set up harmonising the linkup between exposure databases and the 11 individual and 7 administrative cohorts in 10 countries for a total of 35 million participants, dealing with cohort-specific requirements (e.g. georeferencing, governance procedures, data transfer, quality control etc.). A pooled analysis will be conducted of the 11 individual cohorts; data from the administrative cohorts are being analysed locally and combined by meta-analysis. Harmonised European-wide models for PM<sub>2.5</sub>, NO<sub>2</sub>, BC and O<sub>3</sub> were developed and explained respectively 71%, 58%, 51% and 62% of spatial variation in measured concentrations. Kriging proved an efficient technique to explain part of residual spatial variation for PM<sub>2.5</sub> and O<sub>3</sub>. To facilitate further harmonisation, the cohorts implemented the ELAPSE codebook, including specified definitions for socio-economic status. We successfully pooled data and assigned exposure for several of the individual cohorts, and assigned exposure to most of the administrative cohorts. Analyses of associations between low-level air pollution and morbidity and mortality endpoints are ongoing.

### **S01.01.36. U.S. Centers for Disease Control and Prevention's (CDC) National Environmental Public Health Tracking Program**

Fuyuen Yip

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Abstract: The mission of the United States Centers for Disease Control and Prevention's (CDC) National Environmental Public Health Tracking Program (Tracking Program) is to provide information from a nationwide network of integrated health and environmental data that drives actions to improve the health of communities. In collaboration with partners, the Tracking Program identifies priority environmental health issues, determines key surveillance questions, and evaluates the utility of existing data for answering the question and informing the issue. Selected data are integrated into the National Environmental Public Health Tracking Network and used to (1) describe temporal and spatial trends in disease and potential environmental exposures, (2) identify populations most affected, (3) generate hypotheses about associations between health and environmental exposures, and (4) develop, guide, and assess the environmental public health policies and interventions aimed at reducing or eliminating health outcomes associated with environmental factors. Gaps in data are addressed by developing standards for new data collections, models, or new methodologies for using existing data, or by expanding the utility of non-traditional public health data. Current data challenges include the need for more temporally and spatially resolved data to better understand the complex relationships between environmental hazards, health outcomes, and risk factors at a local level. National standards are in development for systematically generating, analyzing, and disseminating small area data and real-time data that will allow for comparisons between different datasets over geography and time.

## S01.01J. Multi-Response and Multi-Pollutant Models for Environmental Exposure and Health: From Gap-Filling to Decorrelating Structure in Data

### **S01.01.37. Identification of Problematic Data Sections and Interpolation of Air Pollution Time-Series**

Dave Riegert

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**Abstract:** Obtaining reliable results from time-series analysis requires complete and error free data and many statistical tools require contiguous data to be usable at all. In the context of measurements from the National Air Pollution Surveillance (NAPS) network we discuss obtaining a data set for use in analysis. We focus on first identifying problematic sections of data and correcting these problems through interpolation, if applicable. A major concern during this process is that because this data is used in decision making it is especially important to avoid introducing new problems while attempting to repair other identified problems. In order to begin addressing any issues present we first must identify that a problem exists, quantify the problem, and flag the points in the data to be corrected. The simplest problem section to identify is one where the data are completely missing. More difficult to identify are sudden or gradual baseline shifts, runs of zero values, runs of saturated values, timing shifts in the data, quantization changes over time, and changes in the autocovariance structure of the data. If a section is to be interpolated we use an interpolation algorithm that is a hybrid Weiner interpolation and consists of an initial interpolation followed by filling each gap individually. This process is iterated until convergence. We discuss: 1) the framework used to allow reproducibility of correction routines and the ability to traceback which operations were performed in the case that any questions of validity arise; 2) the approaches used to identify problematic sections of data; and 3) the interpolation algorithm used.

### **S01.01.38. 15 Years of Air Quality (AQ) Objective Analysis Mapping over North America Using Real-Time Observations and Canadian Operational AQ Forecast Models**

Sylvain Ménard

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Abstract: The Regional Deterministic Air Quality Analysis (RDAQA) is a mapping of surface air pollutant concentration which combines numerical forecasts from the Regional Air Quality Deterministic Prediction System (RAQDPS) and hourly AQ observational data from monitoring surface networks over North America. These include Canadian measurement networks operated by the provinces, territories, and some municipalities and those networks covering the continental United States under the umbrella of EPA's national AIRNow program. The model forecasts and observations are combined based on an optimal interpolation algorithm. The current RDAQA has a horizontal spatial resolution of 10 km and is issued every hour. It provides our best knowledge of the current state of the atmosphere for surface pollutant concentration for chemical species like: ozone, NO<sub>2</sub>, NO, SO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>. The RDAQA also provide a mapping of the Air Quality Health Index (AQHI) in quasi-real time and can be used by meteorologists in Environment Canada's regional forecast offices to inform the public on a daily basis about the health risk associated to short term exposure to air pollution. The RDAQA products available over an extended period of time can also be used by Health Canada and health consortium partners to study how Air Quality and other multiple environmental factors are linked to a wide range of health outcomes. A description of the RDAQA will be presented as well as data access and future plans.

### **S01.01.39. Geometric and Statistical Methods for Aggregating Predictors in Pollutant Risk Models**

Wesley Burr

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Abstract: Multiple pollutant models are increasingly being researched for estimating population health risk due to air pollution while integrating the effects of more than one pollutant at a time. These models have varying approaches for dealing with the inherent correlated structure of air pollutants. In this talk, we examine two new methods for combining such correlated air pollutant predictors in risk models: A geometric and a statistical approach. In the geometric approach we consider the correlated structure of the pollutants embedded in a higher-dimensional space, and combine and interpret the risk estimates as existing on a surface in this space. In the statistical approach, we use the recently developed synthetic lag algorithm for estimation of the phase lag of individual components of the series, and de-correlate the air pollutants so as to make their risks approximately independent. The two methods are then compared and contrasted using several real-world air pollutant and health effect data sets.

## **S01.01.40. Correlated Responses in Air Pollution Regression Models**

Glen Takahara

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Abstract: Bivariate time series responses, specifically daily mortality and morbidity outcomes, in environmental air pollution regression models are of interest in population health studies for at least 2 reasons: (1) for combining risk measures spatially to form regional or national level risk estimates; the correlation between local risk estimates for the two responses can shape the local priors used in hierarchical Bayesian models, which are typically used for combining spatially differentiated estimates. (2) accounting for the two responses explicitly in the regression modeling can allow us to differentiate between pollutant effects on one response, e.g., mortality, that we may classify as "direct" and "indirect", the indirect effects being through the effect of the second response on the first. The current method for accounting the correlation between two responses is to fit each response separately, in two separate models using the same predictors, and then estimating the correlation between the two resulting risk estimates, as both are functions of the same predictors. This approach of estimating the correlation between risk estimates is tailored to address (1). However, it does not address (2). We propose estimating the correlation between the two time series responses in the spectral domain, where it is more commonly referred to as "coherence". In the frequency domain we determine the frequencies at which the two responses are coherent (i.e., correlated). Once this is done we use estimates of the coherent frequencies to estimate periodic structure that is common to both responses. In this way we can decompose one or both responses in the time domain, by inverting the decomposition in the frequency domain back to the time domain, into two or more series where each pair of series are either essentially uncorrelated or one series is a structural part of the other series. We will discuss how this can be used to address the issues raised in points (1) and (2) above.

## S01.01K. Novel Methods for Assessing Complex Exposure Mixtures in Environmental Epidemiology

### S01.01.41. Using Bayesian Shared Mean and Mixture Priors to Study Prenatal Endocrine Disrupting Chemical Mixtures and Neurodevelopment

Ghassan Hamra

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**Abstract:** Background: Exposure to endocrine disrupting compounds (EDCs) is unavoidable. Many EDCs are suspected to impact neurological development of children, especially when exposure is experienced during gestation. However, it is difficult to identify which EDCs are etiologically relevant, which is partly due to the fact that these exposures co-occur. EDC exposures must be studied within a single regression framework, but this task is often complicated by limitations in traditional statistical tools. Methods: We applied Bayesian statistical tools to study the association of a group of EDCs and ASD diagnosis in the Early Markers of Autism cohort, a population based case control study that took place in Southern California. There were 545 children who were diagnosed with Autism Spectrum Disorders based on DSM-IV-TR criteria, 181 with intellectual disability, and 418 general population controls. We applied a shared mean prior and a mixture prior to study the effects of a group of PCB and PBDE congeners, PFAS, and organochlorine pesticides. Chemicals were considered individually, or as a class of compounds (ie, summed PCBs). All models were adjusted for matching factors (child sex, month and year of birth), maternal age, race/ethnicity, parity, and maternal weight at the time samples were collected. Results: We estimated the change in ASD risk per 10-unit increase (ng/g) in EDC exposure. ASD risk was not elevated for any specific EDC. In both the case where we applied a shared mean or a mixture prior, the effect estimates were centered on or near the null. Equally, when we considered summed groups of PBDEs, PCBs, PFAS, and OC pesticides and applied a shared mean, the results were null for all chemical groups. Conclusion: Our results do not suggest a relationship for the EDCs considered here with ASD risk.

## **S01.01.42. A Bayesian Approach to Assess Prenatal Exposures to Metal Mixtures and Associations with Latent Patterns of Neurodevelopmental Trajectories**

Shelley Liu

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**Abstract:** Due to the rise of exposomic research, there is increasing interest in complex mixtures which reflect real life exposure scenarios. Currently, there is limited literature on how exposure to metal mixtures affect neurodevelopmental trajectories. Furthermore, the few existing studies typically do not account for heterogeneity of response to exposure among children, and instead assume that exposure to metal mixtures impacts each child's health to the same degree. In reality, there may be latent subgroups of children with distinct neurodevelopment trajectories, and the impacts of exposure to metal mixtures may differ across these subgroups. We investigate these questions by developing a two-stage statistical model combining growth mixture modeling and Bayesian kernel-learning methods. This novel statistical approach first identifies latent subgroups with growth mixture modeling using time-varying neurodevelopment scores. In a second step, we use a new statistical model called Bayesian varying coefficient kernel machine regression (BVCKMR), to separately analyze each latent subgroup to determine how metal mixture exposures at a single exposure window affect neurodevelopmental trajectories, while adjusting for covariates. BVCKMR can handle dozens of metal mixture components, allowing us to visualize interactions between up to four metal mixture components, while existing studies typically only focus on pairwise interactions. We illustrate this approach by applying it to the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) prospective cohort study based in Mexico City. We will present the association between prenatal metal mixtures and child neurodevelopment, as assessed using the Bayley Scales of Infant and Toddler Development. We demonstrate that the relative importance and interaction patterns between metal mixture components differs by latent class, and show that latent classes may be differentially vulnerable to metal mixtures.

### **S01.01.43. Applying the Bayesian G-Formula to Estimate Impacts of Public Health Actions on Environmental Exposure Mixtures**

Alexander Keil

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Abstract: Environmental exposures do not occur in isolation. Studying environmental mixtures is of great importance, but presents many methodological difficulties. Epidemiological models are specified to estimate exposure-response surfaces, and must make necessary tradeoffs between interpretability and complexity to address aspects of mixtures such as co-exposure confounding and chemical interactions. Furthermore, the conventional approach does not often correspond to public health actions, where policies or regulations may impact a group of exposures within a given mixture. We demonstrate an alternative approach, using the Bayesian g-formula within a causal inference framework to estimate effects of public health actions on exposure mixtures, which allows for flexible models to control confounding and address interaction while also generating easily interpretable results. Additionally, this approach allows incorporation of prior information from toxicologic or epidemiologic studies. We demonstrate our approach in a study of birth outcomes in Milwaukee, Wisconsin in 2005-06 and 2011-12. We linked birth data (using maternal address) with census tract level air toxics data from an EPA emissions-based model, the National-scale Air Toxics Assessment. We estimated the expected prevalence of low birth weight and preterm birth that theoretically would have been observed following a hypothetical intervention to decommission 3 coal-fired power plants in Milwaukee County at the beginning of 2005, to reduce or eliminate several air toxics known to be emitted by coal-fired power plants. While our example is simplified, we demonstrate the utility of this approach for using observational data to directly evaluate policy choices and contrast possible public health actions. Additionally, our analytic approach offers a strategy to reduce the problems of large data demands and statistical assumptions currently required to resolve the epidemiological study of environmental mixtures.

#### **S01.01.44. Characterizing Exposure to Complex Environmental Mixtures with Self-Organizing Maps**

John Pearce

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Abstract: The complexity and dynamic nature of environmental pollution creates many challenges for health investigators seeking to illuminate health effects involving exposure to complex environmental mixtures. This presentation will introduce a statistical learning tool known as the self-organizing map (SOM) as a framework for developing exposure metrics that facilitate the estimation of joint health effects of multipollutant exposure. The first part of the talk will describe the SOM learning approach and will discuss tailoring the technique for epidemiological research. This will include detail on strategies for determining the number of mixtures for subsequent testing and general presentation of results. The second part of the talk will illustrate SOM through examples that center on using results for application within air pollution epidemiologic studies. This will include examples based on EPA's NCORE multipollutant monitoring data and application within an acute health effects study. At the end of the talk, viewers will better understand the benefits and limitations of using a self-organizing map framework for identifying, characterizing, and estimating joint health effects of complex exposures to multiple risk factors.

## 001.02A. Cancer and the Environment

### **001.02.01. Population Attributable Risk and Projected Population Impact Fractions for Lung Cancer and Outdoor Air Pollution in Canada**

Priyanka Gogna

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**Abstract:** Introduction: Outdoor air pollution is classified as a carcinogen by IARC primarily on the basis of a relationship between PM<sub>2.5</sub> and NO<sub>2</sub> and lung cancer risk. This study evaluates the population attributable risk (PAR) and population impact fractions (PIFs) for counterfactual exposure distributions for PM<sub>2.5</sub> and NO<sub>2</sub> on lung cancer risk in Canada. In addition, census dissemination area-level PM<sub>2.5</sub> and NO<sub>2</sub> exposure measures from 1980-2014 were used to calculate PAR estimates, analysis of PM<sub>2.5</sub> and NO<sub>2</sub> trends overtime, and counterfactual PIFs. Methods: Using relative risk estimates calculated from a Canadian-specific meta-analysis, the relationship between PM<sub>2.5</sub> and NO<sub>2</sub> and lung cancer risk was modeled. This analysis assumed a log-linear dose response for a continuous exposure, representing levels during the relevant window of 20 years, with a 5-year lag. Exposure at the dissemination-area level, and a geographically weighted regression model was used to calculate PM<sub>2.5</sub> and NO<sub>2</sub> distributions from 1990-2009, allowing for PAR calculation for 2015, change in PM<sub>2.5</sub> and NO<sub>2</sub> levels overtime, and PIF counterfactuals. Results: Meta-analyses of four Canadian studies for PM<sub>2.5</sub> and NO<sub>2</sub> and lung cancer risk resulted in pooled relative risk estimates of 1.07 (95% CI: 1.03-1.10) per 10 µg/m<sup>3</sup> for PM<sub>2.5</sub>, and 1.05 (95% CI: 1.02-1.09) per 10 ppb for NO<sub>2</sub>. Calculated PAFs for PM<sub>2.5</sub> and NO<sub>2</sub> were 5.4% and 7.9% respectively. Analysis of trends overtime suggested levels have decreased by 0.27 per 10 µg/m<sup>3</sup> for PM<sub>2.5</sub> and 0.56 per 10 ppb for NO<sub>2</sub> per year from 1980-2014. In light of observed trends, a 50% reduction in PM<sub>2.5</sub> and NO<sub>2</sub> is considered feasible. Counterfactuals reducing exposure by 50% are associated with a PIF of 5.6% for PM<sub>2.5</sub>, and 4.0% for NO<sub>2</sub>. Conclusion: These results quantify the proportion of incident cancer cases in Canada that could be prevented through changes in modifiable environmental exposures. Planned analysis will calculate PIFs based on projected exposure scenarios.

## 001.02.02. Outdoor Particulate Matter (PM10) Exposure and Lung Cancer Risk in the EAGLE Study

Dario Consonni

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**Abstract:** Background. Several cohort studies in Europe showed an association of outdoor PM10 exposure with lung cancer risk. Overall, cohort studies in North-America showed no association. Only a case-control study on lung cancer and PM10 in South Korea has so far been performed. Objectives. In this study we evaluated the association between exposure to particulate matter with aerodynamic diameter  $\leq 10 \mu\text{m}$  (PM10) and lung cancer risk within the Environment And Genetics in Lung cancer Etiology (EAGLE) study, a population-based case-control study performed in the Lombardy Region, north-west Italy, in 2002-2005, which enrolled 2100 cases and 2120 controls frequency-matched for area of residence, gender, and age. Methods. We included subjects living in the same city since 1980 with complete histories of smoking (active and passive). Fine resolution annual PM10 estimates obtained by applying land use regression modeling to satellite data calibrated with fixed site monitor measurements were used. We assigned each subject the PM10 annual average estimates for year 2000 based on enrollment address. We used logistic regression to calculate odds ratios (OR) and 95% confidence intervals (CI) adjusted for area, gender, age, education, smoking, diet, and exposure to occupational lung carcinogens. Results. We included 3473 subjects, 1665 cases (1318 men, 347 women) and 1808 controls (1368 men, 440 women), with annual average levels of PM10 ranging from 37.6 to 48.6  $\mu\text{g}/\text{m}^3$ . We found increasing lung cancer risk with increasing PM10 category (P-value for trend: 0.03). The OR per 10  $\mu\text{g}/\text{m}^3$  was 1.29 (95% CI: 0.95-1.72). The association appeared stronger for squamous cell carcinoma (OR 1.45). Conclusions. In a population living in highly polluted areas in Italy, our study added evidence to the existence of a positive association between PM10 exposure and risk of lung cancer. This study emphasizes the need to strengthen policies to reduce airborne pollution.

### **001.02.03. Ambient NO2 Exposure and Respiratory Cancer Risk in São Paulo, Brazil**

Roel Vermeulen

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Abstract: The International Agency for Research on Cancer (IARC) has classified outdoor air pollution as carcinogenic to humans (Group 1). This evidence has been based on predominantly studies from the global North. However, there is a dearth of evidence from low-middle income countries, including those within South America. We studied the association between exposure to ambient air pollution and mortality of respiratory cancers in the city of São Paulo, Brazil. Mortality data (between 2002 and 2013) for all individuals above the age of 20 years was derived from the Municipal Department of Health. Outcomes of interest were coded by the International Classification of Diseases (ICD-10). A total of 19,500 deaths attributable to respiratory cancers (12,826 in men, 6,674 in women) were geocoded by residential zip code. Annual estimates of NO<sub>2</sub> (between 1997 and 2011) were obtained from the global NO<sub>2</sub> land use regression model. Study population was divided in five exposure groups based on centiles of exposure: 0-25, 26-50, 51-75, 76-90 and > 90. Age-adjusted Binomial Negative Regression models were developed, stratifying by deprivation index and gender. We observed an increased risk of respiratory mortality in association with increased NO<sub>2</sub> concentrations. The IRRs for all individuals ranged from 1.10 (95% CI 1.03-1.18), in the lower exposed group, to 1.30 (95% CI 1.20-1.41) in the highest exposed group. The IRRs among men ranged from 1.07 (95% CI 0.98-1.16) to 1.26 (95% CI 1.14-1.39) and women ranged from 1.16 (95% CI 1.04-1.30) to 1.36 (95% CI 1.20-1.55). Our results showed that exposure to ambient NO<sub>2</sub> were associated with an increased risk of mortality of respiratory cancers in the city of São Paulo. These results strengthen the observation on air pollution and lung cancer risk by extending the evidence base to South-America aiding to a more refined estimate of the Global Burden of Disease of air pollution to health.

## **001.02.04. Cancer Incidence in the Agricultural Health Study Farmers: Is the Lung Cancer Deficit Due to Endotoxin?**

Catherine Lerro

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Abstract: Compared to the general population, agricultural populations have lower incidence of overall cancer, in part driven by lower lung cancer rates. This deficit is partially due to lifestyle factors (e.g. lower smoking rates). Endotoxin, a component of gram-negative bacterial cell walls, is a common exposure among farmers and is associated with lower lung cancer risk. In Agricultural Health Study (AHS) farmers, we evaluated overall cancer incidence, and the contribution of endotoxin to the observed lung cancer deficit. We calculated age, year, sex, and race-adjusted standardized incidence ratios (SIR) and 95% confidence intervals (CI) for individual cancer sites in the AHS relative to the general population in Iowa and North Carolina. For lung cancers, we stratified SIRs by AHS-reported smoking and likely endotoxin exposure (raise animals or handle stored grain  $\geq$ once/year). Overall AHS cancer incidence was lower than the general population (n=8256, SIR=0.91, CI:0.89-0.93), with deficits for lung, bladder, pancreas, and liver cancer, and excesses for lip and prostate cancer, B-cell lymphoma, and acute myeloid leukemia. Lung cancer incidence in the cohort was about half of that in the general population (SIR=0.51, CI:0.48-0.55). Comparing AHS smokers to the general population (smokers and non-smokers), we still observed fewer than expected lung cancers (SIR=0.84, CI:0.78-0.91). The deficit of lung cancers remained for endotoxin exposed smokers (SIR=0.74, CI:0.67-0.81), while among endotoxin unexposed smokers we observed a lung cancer excess (SIR=1.15, CI:1.01-1.30). AHS cancer incidence patterns may give us clues to farm exposures' relevance to cancer etiology. Lung cancer incidence was lower than expected in the general population; smoking did not entirely explain the deficit. Endotoxin exposure is protective against lung cancer, and along with lower rates of smoking may contribute to the low lung cancer incidence in our agricultural study population.

## **001.02.05. Prostate Cancer Characteristics Are Associated with Overall Environmental Quality**

Jyotsna Jagai

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**Abstract:** Prostate cancer (PC) is one of the most common cancer types in the United States (US). Cumulative environmental exposures have been associated with PC incidence. However, the impact of cumulative environmental exposures on PC aggressiveness is not well understood. To address this gap, we utilize the U.S. Environmental Protection Agency's (USEPA) Environmental Quality Index (EQI) to estimate county-level environmental quality in the US. The EQI captures exposures to  $\geq 200$  environmental factors across five domains (air, water, land, sociodemographic, and built) for 2000-2005. For persons diagnosed with PC from 2010-2014 ( $n=252,313$ ), prostate specific antigen (PSA), biopsy Gleason score (bGS), and individual level covariates (age, sex, race, etc) from the Surveillance, Epidemiology, and End Results Program (SEER) were linked to the EQI based on place of residence. PSA, a measure of protein produced by the prostate gland and used as a screening tool, was dichotomized ( $PSA \geq 20$  vs.  $< 20$ ) and bGS, a score used to assess the aggressiveness of PC, was also dichotomized (high grade vs. low grade). We used mixed effects logistic regression to model EQI and domain-specific indices as quartiles (Q4; worst environment) to estimate odds ratio (OR) and 95% confidence interval (CI) for PC characteristics adjusting for individual-level covariates. PSA at diagnosis was not associated with overall environmental quality (EQIQ4:  $OR=0.96(0.86,1.06)$ ). Overall environmental quality was positively associated with increased odds of more aggressive PC as measured by bGS (EQIQ4:  $OR=1.14(1.02,1.28)$ ) with the strongest associations seen in the sociodemographic (SDQ4:  $OR=1.26(1.14,1.39)$ ) and built (BQ4:  $OR=1.14(1.02,1.27)$ ) domains. These results suggest associations between poor environmental quality and more aggressive PC at diagnosis. However, additional research is required to understand specific environmental drivers of PC aggressiveness. This abstract does not necessarily reflect USEPA policy.

## **O01.02.06. Public Health Ontario's Environmental Burden of Disease Project**

Susan Greco

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**Abstract:** Previous estimates of the portion of disease attributable to exposure to environmental hazards range from 3% to 23%. Public Health Ontario (PHO), a Crown corporation that provides scientific and technical advice to decision-makers in order to protect and promote the health of Ontarians, is working to estimate the environmental burden of disease (EBD) for its ~14 million residents. Due to methodological and operational considerations, we separated the diseases into cancer and "non-cancer" categories and generated the estimates sequentially. First, PHO collaborated with Cancer Care Ontario to assess cancer risk from population-level exposure to 23 carcinogens found in indoor and outdoor air, food, drinking water, and indoor dust using predominantly a risk assessment framework. The work, published in 2016, identified exposure to sunlight, radon, and air pollution as the top contributors to the environmental burden of cancer in Ontario. Since then, PHO has focused on estimating non-cancer diseases attributable to 11 environmental exposures including air pollution, foodborne and waterborne pathogens, aeroallergens, temperature, noise, and radiation. Leveraging exposure, census, and health administrative data, we conducted a probabilistic EBD analysis to estimate the physician office visits, emergency department visits, hospitalizations, and deaths attributable to the first four exposures listed above. Based on our approach, for example, we attributed approximately 2,000 hospitalizations and 6,000 premature deaths to air pollution and 7,000 hospitalizations and 100 premature deaths to foodborne pathogens (mean values). We plan to rank the burden across all environmental exposures, including the 23 carcinogens. Knowledge translation products and activities will continue to be tailored to reach decision-makers with the ultimate aim of reducing population-level exposure to high priority environmental hazards in Ontario.

## 001.02B. Cardiopulmonary Outcomes Associated with Long-Term Exposure to Air Pollution

### 001.02.07. Long-Term Exposure to Air Pollution and the Incidence of Chronic Obstructive Pulmonary Disease (COPD) and Asthma: A Population-Based Cohort Study in Ontario, Canada

Li Bai

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**Abstract:** Background. Air pollution affects respiratory health, particularly children's lung development and exacerbation of chronic obstructive pulmonary disease (COPD). As the role of low air pollution levels in the development of COPD and adult-onset asthma remains uncertain, we examined their associations and characterized the shapes of concentration-response (CR) relationships in Ontario, Canada. Methods. We conducted a population-based cohort study of ~5.1 million adults, who were aged  $\geq 35$  years and free of asthma or COPD at baseline. From 2001 to 2015, we estimated 3-year average exposures of fine particles (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and ozone (O<sub>3</sub>) from satellite-derived data, land-use regression models, and fusion-based methods, respectively, at residential postal codes. Oxidant capacity (Ox) was the redox-weighted average of NO<sub>2</sub> and O<sub>3</sub> (Ox). We used Cox proportional hazards models to estimate associations between air pollutants and outcomes, while controlling for individual and contextual covariates. We also conducted sensitivity analyses, such as further adjusting for deprivation. The shape of the CR relationship was examined using newly developed non-linear risk models based on optimal transformation of exposure concentrations. Results. 340,733 and 218,005 individuals developed COPD and asthma, respectively. Each interquartile range increase of PM<sub>2.5</sub> was associated with a 7% increase in the incidence of COPD (95% CI: 1.06-1.08). Similarly, NO<sub>2</sub>, O<sub>3</sub>, and Ox were significantly associated with 3-4% increased risk of COPD. We did not detect any strong evidence linking air pollution to asthma. Similar results were observed in most sensitivity analyses. When adjusting for deprivation, the association between PM<sub>2.5</sub> and COPD attenuated slightly (HR 1.04; 1.03-1.05), whereas O<sub>3</sub> and Ox attenuated to the null. The CR relationships for COPD showed sublinear associations. Conclusions. Exposure to air pollution was associated with increased COPD incidence, but not with asthma.

## 001.02.08. Associations between Ambient Air Pollution Exposure, Lung Function and COPD: Results from the UK Biobank Cohort

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**Abstract:** Introduction Ambient air pollution increases the risk of respiratory mortality but evidence for impacts on lung function and obstructive lung disease is less well established. Methods Modeled ambient particulate matter (PM<sub>2.5</sub>, PM<sub>10</sub> and PM<sub>coarse</sub>) and nitrogen dioxide (NO<sub>2</sub>) concentrations were linked to residential addresses of 242 159 UK Biobank Cohort participants. Cross-sectional analyses were performed to examine the relationship between air pollutant concentrations and forced expiratory volume in 1 second (FEV<sub>1</sub>), forced vital capacity (FVC), and COPD (FEV<sub>1</sub>/FVC < lower limit of normal), controlling for relevant confounding factors. Stratified analyses were performed for sex, age, obesity, smoking status, household income, 'ever had asthma' status, and occupation associated with increased COPD risk. Results Mean annual PM<sub>2.5</sub> and NO<sub>2</sub> exposures were 9.92 µg/m<sup>3</sup> (SD: 1.04) and 26.23 µg/m<sup>3</sup> (SD: 7.54), respectively. NO<sub>2</sub> concentrations were highly correlated with PM<sub>2.5</sub> (r=0.87), but less so with other PM metrics. Higher exposure to all pollutants showed significant negative associations with lung function. A 5 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure was associated with lower FEV<sub>1</sub> (-77.86 mL [95%CI: -87.85, -67.87]) and FVC (-61.09 mL [95% CI -73.15, -49.03]). For each 10 µg/m<sup>3</sup> increase in NO<sub>2</sub>, lower FEV<sub>1</sub> (-32.26 mL [95%CI: -34.90, -29.62]) and FVC (-32.77 mL [95%CI: -35.96, -29.59]) were also observed. COPD prevalence was associated with higher concentrations of PM<sub>2.5</sub> (OR 1.42 [95%CI: 1.32 to 1.52], per 5 µg/m<sup>3</sup>) and NO<sub>2</sub> (1.10 [95%CI: 1.07, 1.12], per 10 µg/m<sup>3</sup>), but not with PM<sub>10</sub> or PM<sub>coarse</sub>. In lung function analyses, stronger association were seen for males, lower income households, and individuals with 'at-risk' occupations. COPD associations were stronger amongst obese, lower income and non-asthmatic participants. Conclusion Air pollutant concentrations were clearly associated with decreased lung function and increased COPD prevalence in this large cross-sectional analysis.

## **001.02.09. Ambient Air Pollution Exposure and Risk and Progression of Interstitial Lung Abnormalities: The Framingham Heart Study**

Mary Rice

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**Abstract:** Background: Ambient air pollution accelerates lung function decline among adults, but few have examined if pollution affects risk and progression of interstitial lung disease. Aims: To evaluate associations of long-term exposure to fine particulate matter (PM<sub>2.5</sub>), elemental carbon (EC, an indicator of combustion-related pollution), and major roads with odds of interstitial lung abnormalities (ILA) and progression of ILA on repeated computed tomography (CT) imaging. Methods: We ascertained ILA on chest CT obtained from 2,618 Framingham participants from 2008-2011. Among 1,846 who completed a cardiac CT in 2002-2005, we determined interval ILA progression. We assigned distance from home address to major roadway, 2004-2008 PM<sub>2.5</sub> average estimated by a spatio-temporal model that uses satellite data, and 2004-2008 EC using a spatio-temporal prediction model. Logistic regression models were adjusted for age, sex, height, weight, cigarette smoking, second-hand tobacco, neighborhood household value, cohort, and date. Results: Among 2,618 chest CT's, 176 (6.7%) had ILA, 1,361 (52.0%) had no ILA, and 1,081 (41.3%) were indeterminate. Among 1,846 with preceding cardiac CT's, 118 (6.4%) had interval ILA progression, 956 (51.8%) had no ILA progression, and 772 (41.8%) were indeterminate. Median (interquartile range, IQR) 5-year exposure was 9.9 (1.3)  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub> and 0.44 (0.14)  $\mu\text{g}/\text{m}^3$  for EC. In fully adjusted models, an IQR difference in 5-year EC exposure was associated with a 1.26 (95% CI 1.03, 1.55) times greater odds of ILA, and a 1.33 (95% CI 1.02, 1.73) times greater odds of ILA progression. Associations were similar in multinomial regression models including indeterminate CT scans. We did not observe consistent associations of PM<sub>2.5</sub> or proximity to roadway with odds of ILA or ILA progression. Conclusions: Exposure to combustion-related pollution may increase risk of progressive ILA, however, associations with other measures of particulate pollution were inconclusive.

## 001.02.10. Long-Term Exposures to Air Pollution and the Risk of Atrial Fibrillation

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**Abstract:** Background: Atrial fibrillation (AF) is the most common heart rhythm disorder and is associated with substantial morbidity and mortality. Established risk factors explain only 50%-60% of AF cases, therefore identification of novel population-level risk factors is vital. Short-term exposures to air pollution have been associated with AF triggering, however, only a single study has examined associations between long-term exposures and AF incidence. Methods: We used information from the Women's Health Initiative to explore the association between annual average exposures to PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub>, and risk of incident AF. Exposures were estimated at each address from nationwide spatiotemporal models and distance to road was calculated. Cases of AF were identified through linkage with Centers for Medicare & Medicaid Services data. Time-varying Cox proportional-hazards regression models were adjusted for known AF risk factors and splines were used to assess deviations of the exposure-response functions from linearity. Results: Among 78,060 eligible participants, there were 15,288 incident cases of AF. Only associations with PM<sub>2.5</sub> were linear. Increasing exposures to PM<sub>2.5</sub>, PM<sub>10</sub>, and SO<sub>2</sub> were not associated with higher risk of AF. NO<sub>2</sub>, and living closer to a roadway, however, were associated with higher risks of AF. For example, women with annual average NO<sub>2</sub> exposures in the top quartile (17.1-48.4 ppb) had an HR=1.23 (95% CI: 1.17, 1.29) compared to those in the bottom quartile (0.4-8.0 ppb) and women living furthest from the

largest roads (>5,070m) had an HR=0.96 (95%CI:0.91, 0.99) compared to those living within 1,007m. Findings were similar in sensitivity analyses additionally adjusted for neighborhood SES. (N=70,962; NO2 top quartile HR=1.24 (95% CI: 1.17, 1.31); >5,070m HR=0.97 (95%CI: 0.92, 1.01)). Conclusions: Among this nationwide study of postmenopausal women, increases in traffic-related air pollution exposures were associated with an increased risk of AF.

## **O01.02.11. Associations between Outdoor Fine Particulate Matter Air Pollution and Cardiovascular Disease: Results from the Prospective Urban and Rural Epidemiology Study**

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**Abstract:** Background: Globally, outdoor fine particulate matter (PM<sub>2.5</sub>) air pollution is estimated to account for a substantial proportion of morbidity and mortality from Cardiovascular disease (CVD), yet few prospective studies have examined the full range of global PM<sub>2.5</sub> air pollution exposures. Methods: We evaluated the relationship between outdoor PM<sub>2.5</sub> and CVD for 152,115 adults aged 35-70 from 27 countries within the Prospective Urban and Rural Epidemiology (PURE) study. We estimated outdoor PM<sub>2.5</sub> concentrations (range: 2-103 µg/m<sup>3</sup>) for 721 urban/rural communities (representing neighborhood in urban areas and small villages in rural areas) using satellite estimates calibrated with available ground based monitoring data. Cox proportional hazard frailty models were used to examine relationships between community PM<sub>2.5</sub> and CVD events, controlling for a comprehensive set of individual, household and geographic covariates. Findings: After a median follow-up period of 8.7 years, we recorded 7,030 CVD events (CVD death or non-fatal myocardial infarction, stroke or heart failure) and 1,710 CVD deaths. We observed an adjusted hazard ratio of 1.08 (95% CI: 1.06-1.10) for CVD events per 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub>. A larger association was observed for stroke [HR: 1.14 (1.11-1.17)] compared to myocardial infarction [HR: 1.05 (1.02-1.09)] events. Results for CVD events were robust to all sensitivity analyses. There was no evidence of an association [HR: 0.98 (0.92-1.04)] for CVD mortality alone. Interpretation: Outdoor PM<sub>2.5</sub> was associated with increased CVD risk in this diverse global prospective cohort study.

## 001.02.12. Long-Term Exposure to Air Pollution and Incidence of Myocardial Infarction: A Danish Nurse Cohort Study

Zorana Andersen

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**Abstract:** Background: Exposure to air pollution has been linked to coronary heart disease, yet still evidence on PM<sub>2.5</sub> and myocardial infarction (MI) incidence has been mixed. Here, we examined the association between long-term exposure to air pollution and incidence of MI. Methods: We used the data from a nationwide Danish Nurse Cohort on 22,438 female nurses (age > 44 years) who at recruitment in 1993 or 1999 reported information on CVD risk factors. We obtained data on incidence of MI from the Danish National Patient Register until end of 2014. Annual mean concentration of PM<sub>2.5</sub> and NO<sub>2</sub> at the nurse's residence since 1970 (1990 for PM<sub>2.5</sub>) was estimated using Danish USBM/AirGIS dispersion model, while road traffic noise levels since 1970 were estimated using Nord2000 model, as the annual mean of a weighted 24h average (Lden). We used time-varying cox regression models to examine the association between 1- and 3-year moving averages of PM<sub>2.5</sub> and 1-, 3-, 10-, and 23-year moving averages of NO<sub>2</sub> with MI incidence. Results: Of the 22,438 women, 590 developed MI during a mean follow-up of 18.3 years. We found statistically significant and positive association between 3-year mean of PM<sub>2.5</sub> and MI in crude model (hazard ratio; 95% confidence interval: 1.22; 1.08-1.37), which attenuated in a fully adjusted model (1.10; 0.95-1.27), per IQR of 5 µg/m<sup>3</sup>. Results were similar for 1-year mean PM<sub>2.5</sub> (1.09; 0.96-1.25) and unchanged after adjustment for road traffic noise (1.10; 0.95-1.27). We found statistically significant positive association between 23-year mean levels of NO<sub>2</sub> and MI in fully adjusted model without (1.10; 0.99-1.22) and with (1.14; 1.01-1.29) adjustment for road traffic noise, per IQR of 9 µg/m<sup>3</sup>. Associations were weaker with shorter exposure windows for NO<sub>2</sub> (1-, 3-, and 10-year moving averages). Conclusion: We found associations between long-term exposure to PM<sub>2.5</sub> and NO<sub>2</sub> and MI incidence, independent of road traffic noise.

## 001.02C. Characterizing Near-Road and Point Sources of Air Pollution

### **001.02.13. Estimating Exposures to Unconventional Oil and Gas Flaring Using Satellite Observations**

Meredith Franklin

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**Abstract:** In recent years there has been a rapid rise in unconventional oil and gas (UOG) extraction, commonly known as fracking. Excess natural gas resulting from UOG extraction is disposed of through flaring, potentially leading to a major source of hazardous air pollution. Quantifying exposures from flaring is very difficult due to the irregularity in production, limited regulation of flaring activities, and sheer number of drilling sites. The Eagle Ford Shale in Southern Texas is one such region that has experienced a nearly tenfold increase in UOG activity since 2010, having a dramatic impact on the residents of this large but mostly rural community. Compounding the issue is the paucity of air quality monitoring, making it near impossible to estimate the impact of the UOG activities in the region. To overcome these issues, we harnessed satellite observations from the Visible Infrared Imaging Spectroradiometer (VIIRS) satellite, which through the recently developed Nightfire algorithm provides identification of locations of flaring sources along with estimates of radiant heat and source area. We applied hierarchical spatial clustering to estimate hotspots of satellite-identified flaring activity, and cross-referenced the clusters with drilling permit data. Seasonal estimates of VIIRS flaring frequency and mean radiant heat intensity were calculated to quantify the amount of flaring at the cluster locations. We identified approximately 47,000 nightly flares from April 2012 through December 2016 in the Eagle Ford Shale, and area of approximately 75,000 km<sup>2</sup>. Nearly 800,000 people live in this region, indicating the extent of flaring that is occurring in close proximity to populated areas. This work has shown that through careful processing of VIIRS Nightfire observations we can generate novel and objective exposure estimates of flaring from UOG activities in areas where traditional exposure assessment is not possible.

## **001.02.14. Strategic Communication of Exposure Science and Environmental Epidemiology**

Virginia Guidry

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**Abstract:** Background: Complex environmental health problems require multidisciplinary solutions and public support. Exposure scientists and environmental epidemiologists can use a range of tools to expand the reach of their work and help translate research findings into informed decisions. We will describe how to manage an online presence, including social media profiles, with a professional lens. Objective: Engaging with traditional media and social media can be daunting, so we will share guidance and concrete examples of how to be effective practitioners. Discussion: Traditional media is still a key source of public information. Effective media interviews require understanding what journalists need, including a timely response and clear, plain language explanations. Describing your science in a non-technical way can be challenging and takes preparation. Social media must be used strategically to maintain high quality and value. We will share examples of message development, for research and related purposes, across social media platforms like Facebook and Twitter. LinkedIn, the premier networking tool, helps to form connections and expose your career to potential employers and collaborators. ResearchGate and Academia provide ways to share manuscripts, presentations, posters, and other communication formats. Such online tools can keep the work alive for much longer than the limited conference presentation time, with a broader audience. We will review environmental health-related examples from active practitioners, common pitfalls, and recommendations for best practices with these platforms. Conclusions: Strategic engagement between scientists and public stakeholders can increase the power and efficiency of science. Engaging in traditional and social media can facilitate the formation and growth of partnerships, increase public awareness of environmental health topics, and inform decisions that can help address environmental health issues on local and global scales.

## **001.02.15. The Mobile Observations of Ultrafine Particles (MOV-UP) Study: Winter 2018 Sampling**

Elena Austin

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Abstract: The Mobile Observations of Ultrafine Particles (MOV-UP) Study is a two-year project intended to quantify air quality impacts of air traffic for communities located near, and below the flight paths of the SeaTac airport. The study aims to assess ultrafine particle concentrations within 10 miles of the airport in the directions of aircraft take-offs and landings over the course of 4 seasons. To date, sampling has been completed for Winter 2018. Over this time period, 16 days of mobile sampling were conducted using a suite of mobile instruments capable of detecting particles between 10-20, 20-36 and >36 nm in diameter on a 10 second time-scale. Black carbon (BC) particle concentration was collected on the 10 second scale as well as the full range of particle size distribution from 10 nm to 1  $\mu$ m on the 1 minute time scale. The mean wind direction during the drives was from the SW. There were two days with wind from the NW, which resulted in reversal of the landing and take-off direction at the airport. A varimax rotated principal component analysis was performed on the 1 minute particle size distribution data and BC concentration, normalized to total particle count. Three components accounted for 74% of the variance observed. The first component, explaining 33% of the variance, shows high loadings of particles with median diameter of less than 20.5 nm. The second component, explaining 23% of the variance, shows high loadings of particles with median diameter of greater than 20.5 nm. The third component, explaining 18% of the variance, shows high proportion of black carbon. The geographic distribution of the component scores suggests that the first component is associated with the aircraft flight path. This study demonstrates the ability of mobile monitoring to detect variations in on-road particle size distribution that may be associated not only with vehicular traffic, but also with distance to flight path within 10 miles of an urban airport.

## **O01.02.16. Characterizing Urban Particulate Matter Vehicle Emission Spatial Distributions with On-Road Black Carbon and Particle Number Observations**

David Miller

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Abstract: Distributed urban emissions contribute to spatially variable air pollutant exposures from neighborhood block to city-wide scales. It is challenging to attribute fine particulate matter (PM-2.5) exposure patterns associated with important public health impacts to specific sources. Tracking primary traffic PM emissions is essential due to diesel emission control policies with uncertain impacts as control technologies age across the vehicle fleet. We investigate spatiotemporal variations in on-road vehicle black carbon (BC), particle number (PN), nitrogen oxide (NO and NO<sub>2</sub>) emission factors to fingerprint the influence of heavy diesel vehicle emissions. Two Google Street-View vehicle platforms performed simultaneous daily mobile measurements in Houston, Texas across 38 census tract communities with a range of socioeconomic status and emission sources. These observations have unprecedented spatiotemporal coverage (~160 km per day from July 2017 to March 2018) and 1-5s time resolution, enabling characterization of exposures and vehicle emission factors aggregated across road segments (30-120m), hours and days of the week. We derive vehicle plume enhancements above background (~10s timescales) and fuel-based emission factors with enhancements relative to carbon dioxide (CO<sub>2</sub>). First, we quantify BC emission factors and their contributions to PM-2.5 enhancements to fingerprint diesel source plumes. Second, we assess the influence of diesel vehicles equipped with particulate filters that exhibit both higher NO oxidation to NO<sub>2</sub> and ultrafine mode particle numbers via NO<sub>2</sub> and PN emission factor distributions respectively. Our approach demonstrates the value of mobile monitoring to characterize vehicle PM source patterns and to evaluate their contributions relative to stationary sources (e.g. cement batch plants) in Houston. These insights are valuable to attribute spatial exposure patterns to specific sources and inform health impact studies and emission mitigation strategies.

## **O01.02.17. Variations in Roadside Gradients of Nitrogen Dioxide Observed in a Range of Urban and Rural Settings**

Ian Longley

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Abstract: Although several previous studies have characterised roadside gradients in traffic-related air pollutants through intensive observational studies, and particularly nitrogen dioxide, it has been difficult to combine results to determine the role of the study setting (particularly climate and local built environment) on those gradients and therefore create a generalised model that can be used for exposure assessment beyond those study settings, or to investigate the role of urban planning in mitigating impacts. This paper combines analysis of 9 different observational studies conducted at different locations in the cities of Auckland and Wellington in New Zealand, and measurements for isolated roadside locations extracted from a national long-term monitoring dataset. Each observational study consisted of repeated roadside transects of passive samplers, whereas the national dataset consists of monthly samples for up to 10 years. Together, these data covered varied settings ranging from open rural sites to more built-up urban sites. Analysis showed that all observational data could be summarised using an exponential decay function. A steeper decay was found for sites that were more built-up or near roads with more congested traffic, but also at the rural study site. A shallower decay was found for more low-rise suburban locations and for roads with smoother traffic flow. Our simple generalised model tended to under-predict observed roadside concentrations in the Wellington region. Ongoing analysis is exploring whether this is related to this region's windy climate.

## **001.02.18. Errors Associated with the Use of Roadside Monitoring in the Estimation of Acute Traffic Pollutant-Related Health Effects**

Donghai Liang

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**Abstract:** Background. Near-road monitoring creates opportunities to provide direct measurement on traffic-related air pollutants (TRAPs) and to better understand the changing near-road environment. However, how such observations represent TRAP exposures for estimating adverse health effect in epidemiologic studies remains unknown. Methods. As part of the Dorm Room Inhalation to Vehicle Emission (DRIVE) study, we measured several common traffic indicators at six indoor and outdoor sites ranging from 0.01 to 2.3 km away from a heavily-trafficked highway artery in Atlanta. We examined spatiotemporal variability trends and assessed the potential for bias and errors when using a roadside monitor as a primary traffic pollution exposure surrogate, in lieu of more spatially-refined, proximal exposure indicators. Results. Primary pollutant species, including NO, CO, and BC declined to near background levels by 20 to 30 m from the highway source. Patterns of correlation among the sites also varied by pollutant and time of day. NO<sub>2</sub>, specifically, exhibited spatial trends that differed from other single-pollutant primary traffic indicators. Notably, roadside monitoring of NO, CO, and BC tended to be more strongly correlated with sites, both near and far from the road, during morning rush hour periods, and more weakly correlated during other periods of the day. We found pronounced attenuation of observed changes in health effects (ranging from 18.1 % near to 49.2% far from highway) when using roadside monitoring as a surrogate for true exposure, and the magnitude varied substantially over the course of the day. Conclusion. Epidemiologic studies using near-road monitoring stations as exposure metrics for individuals living in near-road settings, may be prone to substantial exposure measurement errors. Our findings indicate that near-road monitors should be used along with more spatially-resolved metric to accurately capture biologically-relevant exposure to primary traffic pollution.

## O01.02D. Climate and Health

### **O01.02.19. Impacts of Tropical Deforestation and Increased Heat Exposure on Health and Productivity in Rural Areas: The Case of Forest Dwelling Communities in East Kalimantan, Indonesia**

June Spector

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**Abstract:** There is growing evidence that temperature increases associated with tropical deforestation are having negative impacts on human health and productivity. These changes are projected to disproportionately affect poor, rural populations. We report selected findings from a larger study that aims to characterize heat exposure in primary forest and cleared areas, describe how rural communities are adapting to deforestation, and investigate the impacts of increased heat exposure on human health and productivity. A total of 361 participants from ten villages in East Kalimantan, Indonesia were in the study. Continuous measurements in forested and cleared areas were collected in each village using 3MT heat stress monitors. Households completed surveys that included demographics, health status and medical conditions, and time-use modules. Mean maximum temperatures were 33°C and 37°C in forest and open areas, respectively, and mean forest temperatures were 2.6°C cooler than open areas. We find 74% of participants work only in open areas, while 26% work in forests and open areas. Self-reported heat-related illness symptoms in the past week were 4.1% higher among those working only in open areas. Participants reported modifying work schedules to adapt to heat, with nearly 75% of participants working less than in previous years and 37% unable to work the hours they would like in a day. Participants working only in open areas took longer midday breaks and worked longer afternoon shifts. Questions on future adaptation to hotter temperatures indicate more than a third of participants will work less or shift work schedules to avoid the hottest periods of the day. Our findings indicate that heat exposure is higher in deforested areas and adaptation strategies to avoid heat will impact work and productivity in this population.

## 001.02.20. Disappearing Seas: Assessing Dust and Respiratory Health in a Changing Climate

Jill Johnston

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Abstract: Across the southwestern US, particulate matter (PM) in the form of wind-blown dust is emerging as an increasingly prevalent exposure of public health concern. Changing weather patterns, droughts and competing water demands are dramatically altering the landscape and creating conditions conducive to the production of wind-blown dust. In California, such factors are leading to the rapid shrinking of the Salton Sea, a 350-square mile land-locked "sea" situated near the southeastern rural border region known as the Imperial Valley. A regional water transfer agreement will accelerate the Sea's drying and it is anticipated that large swaths of the lakebed will become exposed, leaving behind highly emissive salt flats containing toxic metals, pesticides, and other contaminants. Through a community-academic partnership with Comite Civico del Valle and local elementary schools, we developed a children's respiratory health survey among 1st and 2nd graders to assess baseline health conditions in a rural environmental justice community and collected PM filters at schools to assess the composition of respirable dust. 292 families at four schools participated in the 2017 baseline survey (73% participation) of which 93% identified as Latino/a and 56% reported a household income below \$30,000 per year. 45% of children reported wheezing and 42% had allergy symptoms. Over one-quarter of the children (range 16-30% by school) reported having doctor diagnosed asthma and had used rescue medication in the past year. Preliminary analyses of filter samples during 3 sampling periods showed variability in PM levels by location and by sampling period. Highest average PM<sub>10</sub> and PM<sub>2.5</sub> levels were observed in May 2017. Filter samples also contained detectable levels of biological contaminants, including endotoxin and glucans, which also varied spatially and temporally, independent of PM levels. This work suggests a population vulnerable to the potential impacts of a disappearing Sea.

## **001.02.21. Climate Change and Health: A Historical Analysis of Vivax Malaria Outbreak in Moscow (Russia) during 1999-2008**

Natalia Shartova

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**Abstract:** In the early 1990s vivax malaria resurged in Russia affecting the areas that had been malaria-free since 1960s. In total, at least 525 cases of local transmission were recorded during 1999-2009 in the European part of Russia alone. Moscow region consisting of two member states of Russian Federation, Moscow city and Moscow oblast', was most seriously affected with 386 autochthonous malaria cases, including 90 within the city of Moscow alone. The sources of infection were mostly labour migrants from Central Asian countries. The aim of this study is to analyze long-term climatic trends in respect to malaria transmission and to identify natural indicators characterizing the risk of vivax malaria reintroduction in a temperate climate using meteorology, remote sensing and geospatial analysis. Using meteorological data from 16 stations located in Moscow region for 1977-2016 we assessed the elements of malaria season by Moshkovsky's method. The distribution of malaria cases was analysed using Landsat and Spot 5 satellite imagery. The calculation of different environmental variables (including NDVI, LST, LULC etc.) derived from satellite images was conducted for almost 300 water bodies of Moscow city that had been identified as anopheline breeding places by malaria control programme. As a result, environmental indicators for territory typization in relation to malaria have been selected. An increasing trend of two indicators over the last 40 years has been observed: (1) the sums of effective temperatures (otherwise known as growing degree days, GDDs), and (2) the duration of the season of mosquito's effective infection. The most pronounced changes relate to the 2000s. Spatial heterogeneity of other indicators and their trends has been observed. An urban heat island of Moscow city affects malaria epidemiological parameters and became more intense during the period under study.

## 001.02.22. Climate Variability, School Calendar Pattern and Pertussis Epidemic

Yuzhou Zhang

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**Abstract:** Pertussis remains endemic in many areas of the world as a vaccine preventable disease. Little research has been undertaken to discover the correlations between climate, socio-environmental factors and pertussis. This study aims to identify the potential risk factors of pertussis infection and develop an early warning model based on the identified predictors through a case study in China, which has seen a significant increase in cases since 2013. Weekly data on pertussis cases in Jinan from January, 2013 to December, 2017 were obtained from Chinese Infectious Disease Automated alert and Response System. Weather (ie., temperature and rainfall), school calendar pattern (SCP) and search metrics (SM) data in the same period were obtained from National Oceanic and Atmospheric Administration, Jinan Education Department and Baidu Index respectively. A time series decomposition procedure was used to discover the seasonal variations in pertussis. Time series seasonal autoregressive integrated moving average (SARIMA) and regression tree models were then used to combine climate data, SCP and SM to predict pertussis counts. A clear seasonal pattern of pertussis cases was observed with a peak in summer (July-September) and winter (November-January). The time series cross correlation analysis showed pertussis strongly correlated with SM at 2-week lag ( $r=0.75$ ;  $p<0.05$ ), temperature at 7-week lag ( $r=0.31$ ;  $p<0.05$ ) and rainfall at 0-week lag ( $r=0.28$ ;  $p<0.05$ ). The SARIMA model revealed the combination of weather and SM data improved the predictive performance ( $\beta_{temp}=0.14$ ,  $\beta_{rain}=0.08$ ,  $\beta_{SM}=0.06$ ,  $p < 0.05$ ). The regression tree model returned a relative risk (RR) of 2.1 for SCP periods, while the RR almost doubled to 3.9 for temperature $\geq 21$ o C and rainfall $\geq 0.4$ mm. This study offers insight into pertussis transmission dynamics and may facilitate decisions on future preventive strategies. Moreover, weather with SM may enhance pertussis surveillance as they can detect epidemics in real-time.

## **001.02.23. Impact of Climate Change Policies on Environmental Inequalities in Great Britain**

Heathen Walton

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Abstract: The UK Climate Change Act of 2008 requires an 80% reduction in carbon dioxide-equivalent emissions by 2050 compared with 1990. Strategies implemented to achieve this target offer the opportunity to improve public health and reduce environmental inequalities across Great Britain. We investigated the effect of alternative pathways to achieve the carbon dioxide reduction target on particulate and gaseous air pollution levels across different subpopulations in Great Britain. We linked the sophisticated air quality model CMAQ-Urban with the energy systems model UK TIMES to predict air pollution concentrations in 2035 and 2050 for different scenarios (two scenarios meet the emissions reduction target, two do not). We aggregated model outputs (fine particulate matter [PM<sub>2.5</sub>], nitrogen dioxide [NO<sub>2</sub>] and ozone) to the small-area level (ward ~6000 people) and compared concentrations by ethnicity and socioeconomic status. We used data on ethnicity from the 2011 census to classify wards according to their ethnic composition as White or Non-White and a composite small-area socioeconomic indicator to rank wards from the most to least deprived 5th of wards. Both NO<sub>2</sub> and PM<sub>2.5</sub> concentrations were higher in Non-White compared to White wards (9.3 µg/m<sup>3</sup> NO<sub>2</sub> difference) in all scenarios, less so for ozone. In 2011, mean concentrations in the most deprived 5th of wards were 4.3 µg/m<sup>3</sup> higher compared to the least deprived (ratio = 1.37). This difference decreased by 2050 in all scenarios, for example, to 2.8 µg/m<sup>3</sup> in the baseline scenario, showing a narrowing in the air pollution inequality gap (ratio = 1.31). This general pattern varied by region. PM<sub>2.5</sub> and O<sub>3</sub> showed smaller differences. Despite significant reductions in NO<sub>2</sub> and modest reductions in PM<sub>2.5</sub> and ozone in 2050, air pollution inequalities still persist in all scenarios.

## **O01.02.24. Ethical Issues in Climate Change and Health: How Can Environmental Health Research Facilitate Transformative Changes?**

Mathilde Pascal

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**Abstract:** Our world is facing ecological and biological system changes of unprecedented speed, magnitude and extent. Climate change and biodiversity loss, together with other planetary changes, threaten human societies, and illustrate key frailties of our current approach through the applied sciences. First, its incapacity to trigger rapid actions based on scientific knowledge. It took three decades of scientific dissemination to obtain the political consensus of the Paris agreement. Yet, while numerous studies prove that human health is directly relevant to four key aspects of current climate negotiations (mitigation, adaptation, financing, and capacity development) it is seldom discussed as such. Second is the difficulty of thinking in terms of non-linear responses and tipping points. Indeed, the 2°C target of the Paris agreement does not guarantee that some tipping points will not be exceeded. Third is recognition of the impossibility, with current science, to capture the totality of the health impacts of planetary issues. "There is no planet B" emphasizes that there is no control population for research purposes. This problem is solved by considering the puzzle, piece by piece, but few studies explicitly recognize the limitations of this fragmented approach. Facing these frailties, and in the context of limited resources and time, we need to find new ways of thinking. Some researchers claim that critical research questions are no longer about the problems, but about how to facilitate the transformation of society to solve them, considering that we now are in a post-cautionary world. Perspectives include new forms of interdisciplinary collaborations, emphasis on practical knowledge, experiments, and the recognition of values. How can environmental health researchers introduce these perspectives into their work, and contribute to the shaping of new sustainable societies?

## 001.02E. Environmental Exposures and Adult Health Outcomes

### 001.02.25. Brain Activity in Farm Workers Occupationally Exposed to Pesticides in Costa Rica

Ana Maria Mora

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**Abstract:** Background: Exposure to pesticides has been associated with neurobehavioral deficits and structural brain anomalies in animals and humans. We examined the association between pesticide exposure and brain activity in 48 farm workers from the Zarcero County, Costa Rica. Methods: In May-August 2016, we collected urine samples from each worker and quantified concentrations of urinary metabolites for mancozeb (ethylenethiourea, ETU), chlorpyrifos (trichloropyridinol, TCPy), and pyrethroids (3-phenoxybenzoic acid, 3-PBA). We assessed brain activity throughout bilateral prefrontal cortices using functional near-infrared spectroscopy (fNIRS) while participants completed tasks related to verbal working memory (Sternberg test), executive function (Wisconsin Card Sort Test), and attention (go/no-go test). We estimated exposure-outcome associations using linear regression models adjusted for age and education. Results: Median (P25-P75) urinary ETU, TCPy, and 3-PBA creatinine-adjusted concentrations were 1.0 (0.5-1.8), 7.2 (3.3-13.6), and 1.4 (0.7-1.7) µg/L, respectively. We observed that higher urinary TCPy and 3-PBA creatinine-adjusted concentrations were associated with decreased working memory-related brain activity in all eight regions of interest. For example, brain activity at the most posterior region in the prefrontal cortex of the left hemisphere decreased 2.3 (-4.1, -0.5) and 3.3 (-5.5, -1.1) per two-fold increase in urinary TCPy and 3-PBA creatinine-adjusted concentrations, respectively. We also found that executive function-related brain activity at the most posterior region in the prefrontal cortex of the left hemisphere decreased 2.3 (-4.5, -0.1) and 3.6 (-6.7, -0.4) per two-fold increase in urinary ETU and 3-PBA creatinine-adjusted concentrations, respectively. Conclusion: Our findings indicate that farm workers with higher pesticide exposure levels may be under-recruiting neural resources compared to those with lower exposure levels.

## **001.02.26. Organophosphate Pesticide Exposure, Differential Genome-Wide DNA Methylation, and Biologic Function**

Kimberly Paul

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Abstract: Organophosphates (OP) are widely used insecticides that acutely inhibit acetylcholinesterase enzyme activity. In our population-based of Parkinson's disease (PD), we have shown differential DNA methylation levels associated with OP exposure. Here we aim to describe the OP exposure related epigenetic profile using the PANTHER gene ontology classification system. We measured genome-wide DNA methylation levels (Illumina 450k) in 839 participants. We then first performed an epigenome-wide association study to assess the relationship between OP exposure (GIS-based) and methylation. After we assessed the associations between genome-wide methylation markers and OPs, we generated two sets of gene lists. First, genes from the significantly OP-associated CpGs (70 CpGs,  $p < 10e-07$ , 41 genes), and second, genes of CpGs less strictly associated ( $p < 5e-04$ ; 1077 CpGs, 662 genes). Using the PANTHER software, we compared these gene lists with the human gene database (21,042 genes) to test for overrepresentation of molecular functions, biologic processes, and PANTHER pathways using a Fisher's exact test with false discovery rate (FDR) correction. We found among both PD patients and controls, OP exposure was associated with acetylcholine pathways. From the top 41 genes, the most enriched pathway was nicotinic acetylcholine receptor signaling pathway, fold enrichment=15.63,  $p$ -value=1.01e-03, FDR=1.64e-01. From the 662 genes, the top pathway was muscarinic acetylcholine receptor 1 and 3 signaling, fold enrichment=3.90,  $p$ -value=5.36e-04, FDR=4.73e-02. A number of other molecular functions, biological processes, and cellular components were also enriched in the group of 662 genes. These include pyrophosphatase related catalytic activity ( $p$ -value=2.75e-05, FDR=2.64e-03) and postsynaptic membrane components ( $p$ -value=1.33e-03, FDR=2.13e-02). In this investigation, our results suggest that OP exposure influences DNA methylation levels in genes specifically related to acetylcholine pathways.

## **001.02.27. Epigenetic Effects of Gestational Smoking on Developmental Origin of Lung Function Trajectories from Age 10 to 26 Years**

Wilfried Karmaus

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Abstract: Gestational smoking is known to effect DNA-methylation (DNAm) at epigenetic loci (CpGs) in offspring. The objective was to investigate whether these CpGs predict long-term health effects in offspring such as reduced lung function from childhood to adulthood (lung function trajectories). To this end, we tested associations of smoking-related CpGs with the trajectories. A population-based birth cohort was established in 1989 on the Isle of Wight, U.K. The study enrolled 1,456 children between 1989 and 1990. Longitudinal monitoring with lung function measurements (forced vital capacity - FVC, forced expiratory volume in 1 second - FEV1) was conducted at ages 10, 18, and 26 years. The FEV1/FVC ratio was calculated. DNAm was measured in Guthrie cards collected after birth and in peripheral blood at age 10 and 18 years. Due to large differences in lung function between males and females, statistical analyses were stratified by gender, adjusting for blood cell counts. Risk ratios for adverse trajectories were estimated using log-linear models, applying false discovery rates. Trajectories and DNAm at birth were available for 385 females and 395 males. For each outcome (FVC, FEV1, and FEV1/FVC) and in males and females, the trajectory analyses show two main profiles, of which one was with reduced function. In females, multiple CpGs of the PRDM8 gene (coding methyltransferases that predominantly act as negative regulators of transcription) were statistically significantly related to trajectories with reduced FVC, FEV1, and FEV1/FVC levels. In males, multiple CpGs on the NPR2 gene, coding membrane receptors for natriuretic peptides, were associated with reduced lung function trajectories. From birth to age 18, these CpGs seems to be characterized by a more stable methylation pattern. The results suggest that CpGs related to maternal smoking seems to establish a link between intra-uterine smoking exposure and reduced lung function trajectories from childhood to early adulthood.

## **001.02.28. The Association between Urinary Naphthol Level and Structural Change of the Brain - Brain Cortical Thinning and Ventricular Enlargement: A Cross-Sectional Study**

Woojin Kim

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**Abstract:** Background: Dementia is one of the most common disease in South Korea. Active researches are underway for the early prediction of dementia, and image analysis is one of them. Among the structural changes in the brain caused by Alzheimer's disease, this study focused on cortical atrophy and changes related to ventricular enlargement, which are mainly observed at the early stage of onset. Finally We tried to explore that naphthol, one of the PHA(Polycyclic aromatic hydrocarbons), could be a factor in brain structural changes. Methods: A total of 769 subjects from a community-based cohort in South Korea were used in analysis. All subjects measured cortical thickness(mm), brain volume(m<sup>3</sup>), and ventricular volume(m<sup>3</sup>) for all areas of the brain by brain 3T MRI. To show a correlation between urinary naphthol level and structural change of the brain, the multiple linear regression method was used. The model was adjusted by age, sex, education level, body mass index, drinking, smoking, Physical activity, intracranial volume, family history of dementia, and other cardiovascular comorbidity. Subjects with neurological disorders, dementia and MCI(mild cognitive impairment) were excluded from the study. Results: In multiple linear regression models, higher naphthol level showed a decline right entorhinal cortex- One of the biomarkers of early dementia prediction-( $\beta=-0.0273$ , p-value : 0.0089), right superior parietal cortex( $\beta=-0.0079$ , p-value : 0.0328), and left inferior parietal cortex( $\beta=-0.0078$ , p-value : 0.0369). On the other hand, higher urinary naphthol level was associated with lateral ventricle( $\beta=22.9236$ , p-value : 0.0248) and third ventricular( $\beta=28.9807$ , p-value : 0.0325) size. Conclusions: The results of this analysis indicate that urinary naphthol level was partially related with brain cortex thinning and ventricular enlargement in subjects without neurological disease, or cognitive disorder.

**001.02.29. Mendelian Randomization of Arsenic Metabolism as a Risk Factor for Hypertensive- and Diabetes-Related Traits among Adults in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) Cohort**

Molly Scannell Bryan

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Abstract: Much of the research that connects hypertension and diabetes to arsenic has been conducted in populations exposed through drinking water. Recently, dietary rice has been recognized as a significant source of arsenic. The objective of this analysis was to evaluate whether arsenic metabolism efficiency is associated with hypertension and diabetes using a Mendelian randomization framework in a population with high rice consumption but no known water arsenic exposure. Using 12,689 participants from the Hispanic Community Health Study/Study of Latinos, this study examined the relationship between estimated arsenic metabolism efficiency (defined as the percentages of inorganic arsenic, monomethylarsenate (MMA), and dimethylarsinate (DMA) species) and three hypertensive traits and seven diabetes-related traits. The analyses implemented a two-stage Mendelian randomization approach, with the genotype-arsenic metabolism relationships extracted from published literature, and the genotype-trait relationships estimated from a mixed-effect linear model within the HCHS/SOL population that controlled for the complex survey design and admixed ancestry. The analysis was stratified by rice consumption, dichotomized at the top 10th percentile. Among high consumers of rice, each estimated percentage point increase in MMA was associated with increases of 1.08 mmHg in systolic blood pressure and 0.82 mmHg in diastolic (p=0.047 and 0.0167, respectively). Inorganic arsenic was similarly associated with increased diastolic blood pressure (1.1 mmHg/percentage point; p=0.021). DMA, which represents more efficient arsenic metabolism, was associated with lowered diastolic blood pressure (-0.5 mmHg/percentage point; p=0.017). Among low rice consumers, no associations were observed. Evidence for a relationship with diabetes was equivocal. This suggests that dietary arsenic exposure through rice may be a contributor to high blood pressure in the Hispanic/Latino community.

### **O01.02.30. Neurocognitive Function in Adult Residents of a Mining District in Mexico after Reduction of Manganese Exposure**

Horacio Riojas Rodriguez

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**Abstract:** Background.. Little is known on chronic air manganese exposure and its neurotoxic effects once the exposure has diminished. In 2002 adults residents living in communities located in a mining area were identified with adverse neurological effects associated with exposure to manganese in air. Given these results, an Environmental Program Management was designed and implemented.. Four years after the implementation same populations was evaluated with the same neuropsychological tests Objective. The aim of this study was to analyze changes in neurocognitive performance in adults exposed to air Mn and after an intervention and compared with a reference group. Methods. Motor function was evaluated using an adaptation of Luria-Nebraska test; for attention and working memory retention digit tests was used. Both tests was applied before and after the intervention in the same population (58 adults in the mining zone and 30 controls outside this zone) A Cumulative Exposure Index was built for pre and post intervention periods (2002 and 2013). The index was divided in three categories: 0= reference ( ; 1=Below the median and 2= equal or higher the median value. Logistic regression and lineal models for different tests considering age, scholarship, and lead levels were adjusted. Odds Ratios and mean scores on cognitive performance were compared according with exposure levels. Results. Eleven years after the first evaluation and four years after the intervention, significant reduction in air manganese was found. Regarding neuropsychological evaluation, exposed population showed similar performance compared with controls in some motor tests such as verbal regulation (significant improvement). However, this improvement was not observed in other areas such as dynamic organization of motor act, attention and memory work Conclusions. After reducing significantly air Mn concentrations in this areas, the adults show improvement in some of the neuropsychological test while other showed no changes

### **O01.02.31. Urine and Serum Biomarkers of Per- and Polyfluoroalkyl Substances (PFAS) and Fluorinated Alternatives for Human Exposure Assessment**

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Abstract: Per- and polyfluoroalkyl substances (PFAS), man-made chemicals with highly fluorinated carbon chains, are used in many commercial applications. Trace levels of several long-chain PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), have been detected in the blood of almost every American, while short-chain PFAS are seldom detected. These findings may reflect lower exposure to short-chain PFAS or that, in humans, short-chain PFAS eliminate efficiently in urine. Because of changes in manufacturing of long-chain PFAS, short-chain PFAS and fluorinated alternatives, including perfluoroalkyl ether carboxylic acids (e.g., GenX, ADONA), are increasingly used. Moreover, detection of PFAS and fluorinated alternatives in drinking water has raised concerns about potential implications to human health from exposure through contaminated water. We developed an analytical method adequate for large biomonitoring programs like the National Health and Nutrition Examination Survey (NHANES), and report concentrations of 15 C3-C11 PFAS, GenX, and ADONA in urine and serum collected in 2016 from a convenience sample of 50 American residents with no known exposure to these chemicals. In serum, we did not detect GenX or ADONA; detection frequency and concentration patterns of other PFAS agreed with those from NHANES. In urine, we did not detect fluorinated alternatives, and rather infrequently short-chain PFAS (e.g., perfluorobutanoate in 56% of samples, median=0.2 µg/L; 95th percentile=0.6 µg/L). Despite widespread presence in serum, long-chain PFAS in urine were non-detectable (<0.1 µg/L). These results suggest limited exposure to both short-chain PFAS and select fluorinated alternatives in this convenience population, and stress the relevance of selecting the correct biomonitoring matrix to characterize exposure. Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

## 001.02F. Exposures and Health Impacts of Perfluorinated Substances

### **001.02.32. Setting Bench Mark Dose Limits for Perfluorinated Substances with Epidemiological Data**

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**Abstract:** Background/Aim: Limits set for exposure to PFOA (perfluoro-octanoic acid) and other perfluorinated alkyl substances (PFAS), whether as daily intake, water concentrations or serum concentrations, have mostly relied on extrapolation from animal experimental data, with attendant uncertainties. Using the largest available database with a wide range of serum PFOA concentrations, Bench Mark Doses (BMD) as a basis for limits are proposed using the epidemiological data directly. The European Food Standards Authority is also proposing BMDs for these chemicals drawing on epidemiological data. Methods: Using the most replicated health effect associated with serum PFOA - increased lipids, BMD methods have been applied to the largest suitable dataset, the C8 study. With no strong evidence of a threshold, at the lower end of the range (1 to 30 ng/ml) the relation between lipids and serum PFOA is close to linear, so a benchmark limit for hypocholesteremia (total cholesterol > 240 mg/dl) can be established for a given additional risk of this condition. A benchmark response rate (BMR) of a 1% change in response has been used for some epidemiological data and is used here. Results: Serum PFOA in 54,000 adults was median 28 ng/ml (1-99 pctile range 3 to 889). The BMD for PFOA at a 1% BMR, from models not including other PFAS, in terms of serum concentration of PFOA was 4.1 ng/ml, with corresponding BMDL at the lower confidence level of 2.8 ng/ml. PFOA and other PFAS are correlated and models with both exposures yielded shallower slopes and higher BMD values. Conclusions: A BMDL for PFOA of 2.8 ng/ml is close to population background average serum levels, although the BMDL is sensitive to several factors: selecting either change in average cholesterol or risk of high cholesterol, the arbitrary choice of BMR which should reflect the severity of the outcome (other have chosen 5%), and whether other PFAS are included. The inclusion of other PFAS leads to substantially higher BMDL values.

### **O01.02.33. Derivation of the Agency for Toxic Substances and Disease Registry's (ATSDR's) Provisional Minimal Risk Levels (MRLs) for PFOA, PFOS, PFHxS, and PFNA**

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Abstract: An MRL is an estimate of daily exposure to a hazardous substance that is likely to be without appreciable risk of adverse health effects over a specified route and duration of exposure. Perfluoroalkyls are ubiquitous chemicals in the environment; they are readily absorbed but are not metabolized in humans or animals. The primary health effects of concern include hepatic, developmental, and immunotoxic effects. Limitations in the database precluded the use of human studies for MRL derivation, so laboratory animal studies were used. Because of interspecies differences in the toxicokinetics of perfluoroalkyls, there is uncertainty associated with extrapolation of external dose-response relationships from animals to humans. Therefore, rather than using dose as the point of departure (POD), we estimated PODs using animal serum perfluoroalkyl levels. An empirical pharmacokinetic model specific for animal species/strain/sex was used to estimate serum concentrations of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). Serum concentrations for perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) were estimated using measured levels. Assuming that a serum concentration resulting in an effect in a laboratory animal would also result in an effect in humans, we calculated human equivalent doses (HEDs), which are defined as the continuous ingestion dose (mg/kg/day) that would result in steady-state serum concentrations of the perfluoroalkyl species equal to the serum concentration ( $\mu\text{g/mL}$ ) selected as the POD. MRLs were calculated by dividing the HEDs by uncertainty and/or modifying factors. The oral databases were considered adequate for derivation of provisional intermediate-duration MRLs for PFOA, PFOS, PFHxS, and PFNA. Hepatic, immune, and developmental endpoints were the most sensitive targets for PFOA and PFOS. The most sensitive targets were hepatic and thyroid endpoints for PFHxS, and body weight and developmental endpoints for PFNA.

## **001.02.34. Epidemiological Risk Assessment for PFOA**

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**Abstract:** Introduction: Experimental studies of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) exposure in animals have reported developmental effects, liver and kidney toxicity, immune effects, and cancer. The US EPA performed dose-response modeling with some of those data to derive a health advisory of 70 parts per trillion (ppt) for the sum of PFOA and PFOS in drinking water. Relatively high quality human epidemiology studies are also available, particularly for PFOA, allowing risk estimation for communities with chronic exposure at 70 ppt in drinking water. Methods: Expected serum and cumulative serum PFOA concentrations due to long-term consumption of PFOA contaminated drinking water were calculated using a previously published one-compartment pharmacokinetic model. US incidence rates and selected epidemiological findings including several published C8 Science Panel studies were used to assess health risks for those exposures. For studies in which continuous dose-response analysis was not conducted, inverse variance weighted regression was used to interpolate health effect estimates across exposure categories. Results: Long-term consumption of 70 ppt PFOA in drinking water is expected to contribute about 8 ng/mL to serum PFOA above background contributions from other sources. Based on the previously published epidemiological findings, for lifetime exposure the expected number of excess cases of ulcerative colitis is about 5 per 10,000 exposed individuals, and the expected number of excess cases of thyroid cancer is about 2 per 100,000 exposed individuals. For prenatally exposed children, 8 ng/mL of PFOA in maternal serum has been associated with increased frequency of common colds and gastroenteritis, and decreased vaccine antibody concentrations. Conclusions: Biomarker-based epidemiological findings and pharmacokinetic models can be combined to inform health risk assessment for environmental contaminants.

## **O01.02.35. An Updated Meta-Analysis of the Association of Serum PFOA and Birthweight, with an Evaluation of Potential Biases**

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**Abstract:** Background: A recent meta-analysis of 15 studies of PFOA and birthweight found a change of -12.8 grams (95% CI -23.1, -2.38) per ng/ml in maternal or cord blood, and -27.1 grams (95% CI -50.6, -3.6) per log ng/ml PFOA. Almost all studies were done in low-exposed populations. There are now nine new studies, adding 6019 births to the 6937 births in the prior studies. Methods: We conducted a meta-analysis of 24 studies. We approximating untransformed results for study using log transformed PFOA, to allow combining all studies. We also included another large study, excluded from previous analyses, in a sensitivity analysis. Results: We found a change of birthweight of -10.5 grams (-16.7, -4.4) for every ng/ml of maternal or cord blood. After inclusion of one additional large study, we found virtually no evidence of a PFOA effect (-1.0 grams, 95% CI -2.4, 0.4). Restricting to studies in which blood was sampled from mothers early in the pregnancy or shortly before conception (5393 births), we found little association of PFOA with birthweight (-3.3 grams (-9.6, 3.0)). In studies when blood was sampled late in the pregnancy (7563 pregnancies), there was a lower birthweight with higher PFOA (-17.8 (-25.0, -10.6)). Conclusion: Current human evidence provides only modest support for decreased birthweight with increasing PFOA. Studies with a wide range of exposure, and studies with blood sampled early in pregnancy, showed little or no association of PFOA with birthweight. These are studies in which confounding and reverse causality would be of less importance.

### **001.02.36. Serum Per- and Polyfluoroalkyl Substances Levels and Their Predictors in a San Francisco Bay Area Chinese Community**

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**Abstract:** Background: Per- and poly-fluoroyl alkylsubstances (PFAS) have been widely detected in the environment, food, drinking water, and indoor dust, and are associated with adverse health effects. While some PFAS compounds are decreasing in human biomonitoring samples, some populations, such as Asian Americans, have been observed to have higher levels. Method: In 2016, Biomonitoring California and the APA Family Support Services collaborated on the Asian/Pacific Islander Community Exposures (ACE) Project to biomonitor Chinese adults in the San Francisco Bay Area. We recruited 100 participants and collected exposure information, urine, and blood samples. Sera were analyzed for 32 PFASs by liquid-liquid extraction high-performance liquid chromatography tandem mass spectrometry. Descriptive statistics were calculated and compared to 2013-2014 National Health and Nutrition Examination Survey (NHANES) levels. Additionally, we performed univariate and multivariable linear regression to identify demographic factors predicting increased exposure. Results: Fourteen PFAS were detected with 11 detected in over half of participants. ACE participants' geometric means were higher for perfluorooctane sulfonic acid (PFOS) (24%) and perfluorononanoic acid (PFNA) (43%) compared to all adults in the 2013-2014 NHANES but comparable to the subset of non-Hispanic Asians. For perfluorooctanoic acid (PFOA) and perfluorohexane sulfonic acid (PFHxS), our participants' levels were lower than both NHANES participants as a whole and the Asian subgroup. Demographic characteristics that were positively associated with several of the four most frequently detected chemicals included younger age, smaller portion of life spent in the US, and male sex. Percent of variance explained ranged from 10- 31%. Conclusion: This study illustrates the changing landscape of PFAS compound prevalence and the need for sub-population investigations to identify disparities in exposure for policy and education needs.

## 001.02G. Exposures in Contaminated Communities and Children's Health

### 001.02.37. In Utero Dioxin Exposure and Age at Menarche in the Seveso Second Generation

Marcella Warner

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**Abstract:** Introduction: In utero exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), a widespread environmental contaminant and potent endocrine disrupting compound, is associated with delayed pubertal development in animal studies. On July 10, 1976, an explosion at a chemical plant near Seveso, Italy exposed nearby residents to high levels of TCDD. The Seveso Women's Health Study (SWHS), initiated in 1996, is the only study to date of TCDD's health effects in a female population with the unique benefit of individual TCDD measured in blood collected near the time of the explosion. In 2014, we enrolled SWHS offspring (those exposed in utero to TCDD) in the Seveso Second Generation study. We examined the relationship of in utero TCDD exposure with reported age at onset of menarche among SWHS daughters. Methods: Age at onset of menarche (in years) was collected by maternal or self-report at interview in 341 SWHS daughters. We defined in utero TCDD exposure as initial (1976) maternal serum TCDD level and TCDD extrapolated to pregnancy. Data were analyzed using Cox proportional hazards models. Results: At interview, 287 daughters were postmenarche, averaging 25.6 ( $\pm 8.0$ ) years of age. The mean reported age at menarche was 12.1 ( $\pm 1.3$ ) years. Overall, we found no change in risk of menarche onset with a 10-fold increase in initial maternal TCDD (Hazard Ratio (HR) = 0.91, 95% CI 0.79, 1.06) or TCDD estimated at pregnancy (HR = 0.86, 95% CI 0.72, 1.03). When we considered maternal menarche status at explosion as a potentially sensitive developmental exposure window, TCDD estimated at pregnancy (log<sub>10</sub>) was associated with later age at menarche among daughters whose mothers were premenarche at explosion (HR = 0.71, 95% CI 0.50, 1.00) but not postmenarche at explosion (HR = 0.87, 95% CI 0.71, 1.07). Conclusions: These results suggest in utero exposure to TCDD may alter pubertal timing among daughters of women who were prepubescent at the time of the Seveso accident.

## **001.02.38. Peripubertal Urinary Arsenic Concentrations and Subsequent Insulin Resistance among Russian Boys**

Jane Burns

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**Abstract:** Introduction: Inorganic arsenic (iAs) has been associated with type 2 diabetes in adults, but there are few studies in children. We assessed the associations of peripubertal urinary iAs concentrations with insulin resistance (IR) at adolescence among boys in Chapaevsk, Russia. Methods: 516 8-9 year-old boys were enrolled from 2003-2005 in a prospective cohort study of environmental exposures, growth and puberty. At study entry, parents/guardians completed medical history and demographic questionnaires, and speciated urine As concentrations ( $\mu\text{g/L}$ ) were measured with ion chromatography coupled to ICP-MS; LOD=0.5, except arsenate (AsV) =1.0. Follow-up included annual physical exams and biennial collection of fasting blood samples. At ages 10-13 years, 430 boys had IR calculated by the homeostatic model.  $\Sigma\text{iAs}$  was calculated as the sum of arsenite (AsIII) + AsV, and levels were categorized as low (<1.0), medium (1.0-2.0), or high (>2.0). AsIII and AsV were also dichotomized as high vs. low ( $\geq$  vs. < LOD). Total As (tAs), calculated as  $\Sigma\text{iAs}$  + monomethylarsonic acid + dimethylarsenic acid, was categorized by quartiles. Associations of As species with IR were examined by multivariable generalized estimating equations for repeated measures, adjusted for urine specific gravity, age, and BMI. Results: 9.1% of boys had IR. The medians (max) of tAs, AsIII, AsV, and  $\Sigma\text{iAs}$  were 5.9 (254), 0.4 (57), 0.2 (15.7) and 0.7 (62)  $\mu\text{g/L}$ , respectively. In multivariable models, compared to low  $\Sigma\text{iAs}$ , the OR (95% CI) associated with medium and high  $\Sigma\text{iAs}$  were 1.90 (0.85, 4.28) and 2.42 (0.90, 6.52), p-trend=0.06. Of the iAs species, only AsV was associated with significantly increased odds of IR, with OR=2.75 (95% CI: 1.17, 6.47). tAs was not associated with IR. Conclusion: In this Russian cohort, higher peripubertal iAs was associated with increased odds of IR over four years of follow-up. Funded by EPA R82943701, NIEHS ES014370, ES000002 & ES024907.

## **001.02.39. Association between Maternal Psychosocial Stress during Pregnancy and Gestational Age in Puerto Rico**

Stephanie Eick

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**Abstract:** Preterm birth (PTB), the leading cause of infant morbidity and mortality worldwide, disproportionately impacts infants in Puerto Rico (PR). Psychosocial stress may be an important risk factor for PTB and hasn't been examined in PR. We examined associations between stress and gestational age continuously and PTB (<37 weeks gestation) using multiple dimensions of stress in order to optimally define exposure. Stress was measured using the Perceived Stress Scale (PSS), Life Experiences Survey (LES), Center for Epidemiologic Studies-Depression (CES-D), and ENRICH Social Support Instrument (ESSI). We included 922 mother-infant pairs of the Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) Cohort, which examines environmental risk factors for PTB in the Northern Karst region of PR. Data on stress measures was collected during the 3rd trimester visit, except for LES, which was collected at the 2nd trimester. Responses on each scale were scored to create a continuous measure. Higher scores on each scale, except the ESSI, were indicative of increased stress. There were 93 PTBs in this analysis. Lower maternal education, unemployment, and public insurance were more common among women who delivered preterm and were associated with higher scores on all stress measures. Higher scores on the PSS ( $\beta$ : 0.00; 95% CI (confidence interval): -0.02, 0.01), LES ( $\beta$ : 0.01; 95% CI: -0.02, 0.04), ESSI ( $\beta$ : 0.01; 95% CI: -0.02, 0.04), and CES-D scales ( $\beta$ : -0.01; 95% CI: -0.02, 0.01) were not associated with gestational age or PTB. Although our findings show that stress as measured by these scales is not associated PTB, there are other facets of stress, such as anxiety and neighborhood perceptions, that were not captured in our scales but may be important. Our study indicates that stress in pregnancy is not a major risk factor for PTB in our population. Other environmental exposures, such as chemical exposures in pregnancy, will be investigated in this population in the future.

## **001.02.40. Relationship between Thyroid Hormone Levels, Radiation Dose and IQ in Children Exposed In Utero by the Chernobyl Accident and Controls**

Liudmila Liutsko

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**Abstract:** Background/Aim: A previous study, in Belarus, examined psychological development in 250 children exposed in utero to radiation from the Chernobyl accident in 1986 and 250 control children of the same age and sex from areas with little or no contamination. Significant differences in IQ (Intellectual quotient) were reported at age 7 years, but not later. We used data from this study to further explore the possible relationship between dose, thyroid hormones levels and IQ (at the adolescent period). Methods: The data set included information on thyroid hormones: - T3 (triiodothyronine) and T4 (thyroxine) levels; general IQ; radiation dose to the thyroid and gestation week at the time of the accident. We used MANOVA to screen the main significant factors of the study. Descriptive and non-parametric correlation analyses comparing those exposed in utero and the age/sex-matched control group were also conducted. Results: Using MANOVA, a significant increase in T4 and a significant decrease in T3 were seen when comparing those exposed in utero to controls ( $P < 0.05$ ); a significant interaction between dose group, sex and gestational quarter was also found on T4 levels ( $P = 0.001$ ). IQ was significantly decreased in the highest dose category compared to the two lowest dose groups, and was correlated with T3 in both the control and in utero exposed groups, though the direction of the correlation differed and it was significant only in the control group. Conclusion: This preliminary analysis suggests an association between dose and thyroid hormone levels and between these and IQ in our study population. Further in-depth analyses are underway to better characterise these, taking into account possible confounding factors.

## **001.02.41. Association between Liver Function, Hepatic Fibrosis Index and Urinary Thiodiglycolic Acid in School-Aged Children Living near a Petrochemical Complex**

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**Abstract:** Background/Aim Whether children are susceptible to hepatotoxicity when exposed to vinyl chloride monomer (VCM) is unknown. Epidemiological studies revealed high prevalence of liver fibrosis and abnormal liver function in high VCM/PVC exposed workers, and previous study indicated that using urinary thiodiglycolic acid (TDGA) as a biomarker of VCM metabolites is reliable in children living near VCM/PVC factories. We aim to assess the association among urinary TDGA levels, liver function, and hepatic fibrosis in school-aged children. Methods 303 school-aged children (aged  $\geq 6$ - $<13$  years) were recruited in central Taiwan. First morning urine and blood samples were collected in each participants, and urinary TDGA levels were analyzed by LC/MS-MS. Liver function was determined by subclinical abnormal serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT). Hepatic fibrosis was assessed by AST to platelet ratio index (APRI), and fibrosis-4 score (FIB-4). Results Median levels of all subjects urinary TDGA (range), AST/ALT (range; subclinically abnormal rate) were 95.2  $\mu\text{g/g-creatinine}$ , 26.0 IU/L (17.0-99.0; 26%)/15.0 IU/L (7.0-211.0; 6%), respectively. Third quartile of urinary TDGA levels in children (Q3:  $\geq 95.2$  -  $<160.0$   $\mu\text{g/g-creatinine}$ ) and highest quartile (Q4:  $\geq 160.0$   $\mu\text{g/g-creatinine}$ ) had significantly increased the odds ratio (OR) (Q3: OR= 3.54, 95% confidence interval (CI): 1.35-9.30; Q4: OR= 5.26, 95% CI: 1.93-14.31) of subclinically abnormal AST compared with those in the lowest quartile after adjustment for elementary schools, age, sex, BMI, annual family income, physical activity, and passive smoking. A trend for a dose-response ( $p$  for trend= 0.001) was also observed. Conclusions Our findings supported the hypothesis that urinary TDGA levels in children living near VCM/PVC industries are associated with susceptibility to hepatotoxicity.

## 001.02.42. Prenatal Pyrethroid Exposure and Behavioral Problems in 5-Year Old Children from the Infants' Environmental Health Study (ISA)

Jorge Ernesto Peñaloza Castañeda

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Abstract: Background: Pyrethroid insecticides may affect children's behavior, but data from prospective studies are rare. We examined whether prenatal pyrethroid exposure was associated with behavioral problems in 5-year old children from the Infants' Environmental Health Study (ISA). Methods: We interviewed mothers from 5-year old children (mean  $5.7 \pm 0.4$  years) ( $n=292$ ) about their child's behavior during the last two months, administering the Child Behavior Checklist (CBCL). We measured pesticide metabolite concentrations in maternal urine collected 1-3 times during pregnancy: DCCA for the pyrethroids permethrin, cypermethrin, and cyfluthrin, and 3PBA for permethrin, cypermethrin, and deltamethrin. We revised internal consistency of CBCL and analyzed sub-scales with Cronbach-alfa  $>0.7$ : Internalizing, Externalizing, Aggressive, Withdrawn behavior. We ran linear regression models for log-10 transformed prenatal metabolite concentrations and CBCL scales, adjusting for child age, child sex, stressful life events, HOME score, parity, maternal education, and maternal depression. We also examined effect-modification by sex. Results: Median (p25-p25) specific gravity-adjusted DCCA and 3PBA concentrations were 1.3 (0.8-2.4) and 0.8 (0.5-1.4)  $\mu\text{g/L}$  respectively. Higher DCCA concentrations were associated with increased internalizing problems ( $\beta=2.7$ , 95%CI -0.2-5.6, per ten-fold increase in exposure), particularly for boys ( $\beta=5.6$ , 95%CI 1.5-9.6, per ten-fold increase in exposure). Higher 3PBA concentrations were associated with increased externalizing problems ( $\beta=3.0$ , 95%CI -0.2-6.3, per ten-fold increase in exposure), particularly for boys ( $\beta=5.2$ , 95%CI 1.1 - 9.9 per ten-fold increase in exposure). For boys, higher 3PBA was also associated with internalizing problems and aggressive behavior:  $\beta=4.4$  (95%CI 1.1-8.6) and  $\beta=4.1$  (95%CI -0.1-8.3), respectively. Conclusion: Results suggest pyrethroids negatively affect young children's behavior, effects may be stronger for boys.

## O01.02H. Neurodevelopmental Outcomes Associated with Perinatal Exposure to Air Pollution

### **O01.02.43. Associations between Ambient Ozone and Fine Particulate Matter Exposures and Autism Spectrum Disorder in Metropolitan Cincinnati, Ohio**

John Kaufman

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**Abstract:** Epidemiological studies have found fairly consistent associations between various air pollution measures and autism spectrum disorder (ASD) for prenatal and postnatal exposures. We examined associations between ASD and ambient fine particulate matter (PM<sub>2.5</sub>) and ozone concentrations during pregnancy through the 2nd year of life in a study of 428 ASD cases diagnosed at a large regional children's hospital in metropolitan Cincinnati, Ohio, frequency matched (15:1) on birth year to 6420 controls from Ohio birth records. We assigned daily PM<sub>2.5</sub> and ozone estimates from US EPA's Fused Air Quality Surfaces Using Downscaling model to each subject for each day of the study period (2005-2012) based on the census tract of the mother's residence at birth. We calculated adjusted odds ratios (aORs) with logistic regression models using continuous and categorical exposure period averages while adjusting for a priori confounders, other air pollutants, and multiple time windows of exposure. In the multipollutant models comparing highest to lowest sextiles, we detected elevated aORs for PM<sub>2.5</sub> in the 2nd trimester (aOR=1.41, 95% CI: 0.89, 2.24), 1st year of life (aOR=1.54, 95% CI: 0.98, 2.40), and cumulative period from pregnancy through the 2nd year of life (aOR=1.52, 95% CI: 1.00, 2.31), and for ozone in the 2nd year of life (aOR=1.29, 95% CI: 0.81, 2.05). When restricting to male sex, a strong risk factor for ASD, results increased for 3rd trimester PM<sub>2.5</sub> (aOR=1.36, 95% CI: 0.82, 2.25) and the cumulative period from pregnancy through the 2nd year (aOR=1.72, 95% CI: 1.08, 2.76). Though we saw limited evidence of exposure-response relationships, the elevated aORs for PM<sub>2.5</sub> in the upper exposure groups were similar in magnitude to those reported in previous studies. We did not see a consistent pattern of sensitive exposure periods between the two pollutants, but our strongest results for postnatal exposures agree with some previous research.

## **001.02.44. Prenatal and Infant Traffic Related Air Pollution and Autism Spectrum Disorder: A California State-Wide Study**

Ondine von Ehrenstein

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**Abstract:** Background: Studies are accumulating that suggest associations between air pollutants and autism spectrum disorder (ASD) in children. However, most studies include rather small numbers of cases. Our objective was to use data for the state of California focussing on road traffic related exposure during pregnancy and the first year of life to assess related risks for childhood ASD. Methods: We used a registry linkage design based on state-wide California birth data retrieved from Office of Vital Statistics birth rolls 1998-2010. ASD (at the time of our study assessed as autistic disorder (DSM IV-R)) cases (n~35,000) were identified through records maintained at the California Department of Developmental Services and linked to birth records. Birth record controls were matched on sex and year 1:10. Prenatal / first year road traffic related CO, NOx and PM2.5 concentrations from both gasoline and diesel vehicles were estimated using CALifornia LINE Source Dispersion Model 4, a modified Gaussian line-source dispersion model. We estimated risks using logistic regression. Results: Exposure during pregnancy to interquartile-range increases of the correlated pollutants CO, NOx and PM2.5 related to increased odds ratios (OR) for ASD, adjusting for maternal age, education, race/ethnicity, maternal birth place and other potential confounders: CO OR=1.14; 95% CI 1.13, 1.15; NOx OR=1.12; 1.10, 1.13; PM2.5 OR=1.13; 1.11, 1.14. Results were similar for boys and girls. Conclusions: Our state-wide population based study including a large number of ASD cases and avoiding participation bias, indicates increased risks for ASD of around 10% related to prenatal exposure to traffic generated air pollution. These findings confirm and extend earlier smaller studies suggesting the need for public health policies to regulate air pollution exposure to protect the developing fetus.

## **001.02.45. Prenatal PM2.5 Exposure and Neurodevelopment at 2 Years of Age in a Birth Cohort from Mexico City**

Magali Hurtado-Díaz

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**Abstract:** Background: The association between fine particles (PM2.5) and child development has not been assessed based on the Bayley Scales of Infant Development III (BSID-III), in which cognitive and language functioning are analyzed separately. Objective: To examine longitudinally the association between prenatal PM2.5 exposure and cognitive, language and motor development during the first two years of children's life. Methods: Analysis was conducted in PROGRESS, a longitudinal birth cohort enrolled during 2007-2011 in Mexico City. We used mixed-effect regression models to evaluate cognitive, language and motor scores of the BSID-III in 24 month-old children (n=740). PM2.5 was estimated using a validated satellite-based spatio-temporally prediction model. We modeled associations of each of the 3 trimester-average exposures with neurodevelopmental assessment scores, adjusted for potential confounders. Results: In models adjusted by sex of the child, gestational age, birth weight, smoking and mother's IQ, an increase of 1mg/m<sup>3</sup> of PM2.5 predicted a decrease of cognitive and language scores. The most consistent results were in language assessments. At the 24 month follow-up, each unit increase in PM2.5, was associated with a decrease of the language function of -0.38 points (CI95%: -0.77, -0.01). Conclusion: Our findings suggest that language development up to 24 months of age, may be particularly sensitive to PM2.5 exposure during pregnancy.

**001.02.46. Prenatal Exposure to Ambient Air Pollution and Early Childhood Neurodevelopment: A Longitudinal Birth Cohort Study in an Urban Region of the Southeastern U.S.**

Christine Loftus

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**Abstract:** Background: Animal studies indicate that air pollution may be neurotoxic, but evidence in humans is limited. We analyzed associations between prenatal air pollution and childhood neurodevelopment in a large birth cohort in Shelby County, TN. Methods: We included mother-child dyads who completed a preschool visit in the Conditions Affecting Neurocognitive Development and Early Childhood (CANDLE) study. Primary outcomes were internalizing and externalizing behavior scores (Child Behavior Checklist) and full-scale IQ score as a measure of general cognition. Prenatal exposures to nitrogen dioxide (NO<sub>2</sub>) and particulate matter less than 10 microns (PM<sub>10</sub>) at maternal residences were estimated using a national annual average universal kriging model (land-use regression with spatial smoothing). We also measured distance to nearest major roadway as a proxy for traffic-related pollution. In regression models, we adjusted for confounding by individual and neighborhood socioeconomic status, maternal IQ, and other determinants of child neurodevelopment; and tested for effect modification by child sex, maternal race, and prenatal nutrition. Results: The study population (N=1009) was predominantly low-income and 69% African American; mean child age at assessment was 4.4 years. Mean NO<sub>2</sub> and PM<sub>10</sub> exposures were 12.9 ppb and 20.9 µg/m<sup>3</sup>, respectively. In fully adjusted models, a 5 ppb increase in prenatal NO<sub>2</sub> was associated with 13% higher externalizing behavior score (95% CI: 0.5, 28%) and 2.8 times higher odds (95% CI: 1.0, 7.9) of an externalizing score above the clinical threshold. Full-scale IQ scores averaged 2.5 points (95% CI: 0.1, 4.8) lower per 5 µg/m<sup>3</sup> increase in PM<sub>10</sub>. We found no statistically significant evidence of associations with road proximity or interaction by demographics or nutrition. Conclusions: Our findings support the hypothesis that air pollution impairs neurodevelopment. We observed the most consistent associations between NO<sub>2</sub> and externalizing behaviors.

## **001.02.47. Early Life Exposure to Fine Particulate Matter and Working Memory and Attention**

Ioar Rivas

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**Abstract:** Growing evidence has related exposure to air pollution to decelerated cognitive development in children. However, the relevant window of exposure for such an association is yet to be established. The objective of this work was to evaluate the associations between exposures to particulate matter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) at different prenatal and postnatal periods and cognitive function in children to identify important windows of exposure. This study was based on 2,221 children ( $8.5 \pm 0.9$  years old) recruited from 39 schools across Barcelona, Spain (2012). We applied land use regression models to estimate residential PM<sub>2.5</sub> exposure during the prenatal period and the first seven years of life for each participant. Computerized n-back tests to assess working memory (WM) and attentional network tasks (ANT) to assess attentiveness (consistency in response time) and executive function were repeated four times within a year. We used linear mixed effects models with participant and schools as random effects to explore the associations between cognitive development and annual PM<sub>2.5</sub> averages of pre-natal and post-natal exposure, adjusted for relevant covariates. Detrimental periods for WM were identified for the fifth and sixth year of life. An interquartile range (IQR) increase of PM<sub>2.5</sub> at year 6 resulted in a reduction of -4.62 (95%CI: -8.19, -1.04) points in WM. Important differences were observed by sex, with boys having significant negative effects on WM for all the periods except year 2, while no vulnerable period was observed for girls. Periods of significant detrimental effects on the executive function were identified at the prenatal stage and from postnatal year 4 until 7. No significant differences were observed between boys and girls in the attention domains (attentiveness and executive function). Early life exposure to PM<sub>2.5</sub> was detrimentally associated with fundamental cognitive abilities including working memory and executive function.

## **001.02.48. Air Pollution, Neighborhood Deprivation, and Autism Spectrum Disorder in the Study to Explore Early Development**

Laura McGuinn

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**Abstract:** Background: Neighborhood deprivation may modify associations between autism spectrum disorder (ASD) and exposure to early life traffic-related air pollution or particulate matter <2.5  $\mu\text{m}$  (PM<sub>2.5</sub>). Methods: We used data from the Study to Explore Early Development to evaluate these associations, which included 674 cases of children with confirmed ASD and 855 population controls. We assessed associations of ASD with roadway proximity, as a marker of traffic-related air pollution, and with PM<sub>2.5</sub> during the entire pregnancy and first year of life. Pregnancy and first year of life PM<sub>2.5</sub> averages were dichotomized at 12.0  $\mu\text{g}/\text{m}^3$ . To characterize neighborhood deprivation, a weighted index was created, based on eight census tract-level socioeconomic status-related parameters. The continuous deprivation index was categorized into tertiles, representing low, moderate, and high deprivation. Logistic regression was used to estimate odds ratios and corresponding 95% confidence intervals for the associations between roadway proximity, PM<sub>2.5</sub>, and ASD. Modification by neighborhood deprivation was assessed on both the additive and multiplicative scales. Results: There was modification by neighborhood deprivation for the association between PM<sub>2.5</sub> during the first year of life and ASD on the multiplicative scale. The association between PM<sub>2.5</sub> exposure and ASD was strongest in regions of high deprivation (OR=2.42, 95% CI: 1.20, 4.86), compared to the moderate (OR=1.21, 95% CI: 0.67, 2.17) or low (OR=1.46, 95% CI: 0.80, 2.65) deprivation groups. Conclusions: These results provide evidence for an association between first year of life PM<sub>2.5</sub> exposure and childhood ASD, and suggest children living in more deprived neighborhoods may be particularly vulnerable to pollution effects. This abstract does not necessarily represent the official positions of the Centers for Disease Control and Prevention or the Environmental Protection Agency.

## O01.02I. New Policy Directions in Exposure Assessment and Environmental Epidemiology

### O01.02.49. Incorporating Regulatory Guideline Values in Analysis of Epidemiology Data

Chris Gennings

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Abstract: Fundamental to regulatory guidelines is to identify chemicals that are implicated with adverse human health effects and inform public health risk assessors about "acceptable ranges" of such environmental exposures (e.g., from consumer products and pesticides). The process is made more difficult when accounting for complex human exposures to multiple environmental chemicals. Herein we propose a new class of nonlinear statistical models for human data that incorporate and evaluate regulatory guideline values into analyses of health effects of exposure to chemical mixtures using so-called 'desirability functions' (DFs). The DFs are incorporated into nonlinear regression models to allow for the simultaneous estimation of points of departure for risk assessment of combinations of individual substances that are parts of chemical mixtures detected in humans. These are, in contrast to published so-called biomonitoring equivalent (BE) values and human biomonitoring (HBM) values that link regulatory guideline values from in vivo studies of single chemicals to internal concentrations monitored in humans. We illustrate the strategy through the analysis of prenatal concentrations of mixtures of 11 chemicals and two health effects: birth weight and language delay at 2.5 years. The strategy allows for the creation of a Mixture DF, which is a uni-dimensional construct of single chemical DFs, which focuses the resulting inference to a single dimension for a more powerful one degree-of-freedom test of significance. Based on the application of this new method we conclude that the guideline values need to be lower than those for single chemicals when observed in combination to achieve a similar level of protection as was aimed for the individual chemicals. The proposed modeling may thus suggest data-driven uncertainty factors for single chemical risk assessment that takes environmental mixtures into account. (Support: NIH #R01ES028811 and EU Horizon 2020 #634880)

## **O01.02.50. Development of Exposure Assessments under Amended TSCA**

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Abstract: On June 22, 2016, the Frank R. Lautenberg Chemical Safety for the 21st Century Act was signed into law thereby amending the Toxic Substance Control Act (TSCA), the Nation's primary chemicals management law. TSCA requires that the risk evaluation process last no longer than three years (with a possible six month extension) and includes, for the conditions of use of the identified chemical, development of a scope, hazard assessment, exposure assessment, and risk characterization. Given the timeframes mandated by TSCA, EPA has been working to develop strategies to more efficiently assess exposures to environmental receptors, consumers, the general population and susceptible populations while using reasonably available information and relying on the best available science. Exposure assessments will rely on the weight of scientific evidence, which will apply a fit-for-purpose systematic review method for exposure data. This presentation will discuss approaches to develop consistency in identifying and refining pathways and routes of exposure among the first ten existing chemicals identified for risk evaluation. Commonalities and differences in the conditions of use, chemical properties, and available information will be presented as well as a path forward for estimating exposure, including the utilization of information on chemical-specific factors such as physical-chemical properties and environmental fate and transport parameters. Examples will highlight some of the strategies in developing and conducting concurrent consumer exposure modeling scenarios for several of the first 10 chemicals undergoing risk evaluation. The views expressed in this abstract are those of the authors and do not represent Agency policy or endorsement

## **001.02.51. Student Science and Environmental Health Literacy on Hopi Lands**

Mary Kay O'Rourke

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Abstract: The Hopi Environmental Health Project is funded through the Center for Indigenous Environmental Health Research (CIEHR) at the University of Arizona. When introducing the project to the community, the Tribal Chairman stressed the importance of involving Hopi youth in projects that engender an interest in scientific careers. We conducted two "Student Science" projects during 2017-18 through the Hopi Junior/Senior High School. The projects were conducted in four science classes, and involved students in media specific exposure assessment activities related to radon and arsenic exposure. Prior to initiating the school project, a letter was sent home to parents describing the radon (or arsenic) evaluation and stressing that this was a school science project. During the first class meeting, a 15 minute introductory description of radon (or As) was provided by UA students and faculty. Following the presentation, aid was provided for accurate completion of collection forms (radon or water). Bill-caps were offered to students as incentives. Students took the sampling materials (a sorbent air sampler or water test tubes) home and collected samples. Deidentified samples were returned to school with the collection forms and analyzed at a commercial/university laboratory. Data were returned from the designated lab to the ESC. The ESC prepared individual reports for students and placed them in sealed, addressed envelopes for distribution to the "Student Scientists." The concept of confidentiality was discussed. The ESC consolidated data from the four classes and each student received a data sheet containing all deidentified results for evaluation and reported duration or consumption values for each individual. Analysis involved graphing the data, determining the percent of the group exceeding the analyte standard, and calculating individual and group mean exposures. Evaluation of the outreach indicated that most students enjoyed the project and learned the fundamental concepts.

## **O01.02.52. Development and Demonstration of the Environmental Policy Simulation Tool for Electrical Grid Interventions (Epstein), Version 2.0**

Jonathan Buonocore

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Abstract: Renewable energy and energy efficiency (EE/RE) can have benefits to both climate and public health by reducing emissions of both greenhouse gases (GHGs) like carbon dioxide (CO<sub>2</sub>), and air pollutants (APs), including sulfur dioxide, nitrogen oxides, and fine particulate matter. Benefits of EE/RE have been modeled previously, but scalability can be limited by computational resources necessary to run electrical grid and atmospheric dispersion models. Here, we present and demonstrate EPSTEIN 2.0, a platform that can rapidly assess the health and climate benefits of EE/RE across 10 electrical grid regions in the Continental United States. EPSTEIN 2.0 consists of a rapid electrical grid model that simulates changes in power plant operation and emissions in response to new generation sources or decreased demand from EE/RE measures on that grid. The estimated AP reductions are then fed into a model that estimates the health benefits in monetary terms, using a statistical model for air pollution transport, population and mortality rate data, existing concentration-response functions for the relationship between air pollution and mortality, and standard valuation methods for mortality risk reduction. The GHG emissions reductions are monetized using the Social Cost of Carbon. Our demonstration runs of 200 MW wind, utility-scale solar, and rooftop solar across the Continental U.S. reveal that EE/RE benefits can vary by an order of magnitude across types and locations, for a given capacity of project. This reflects differences in electrical grid mix, downwind populations, and performance of each EE/RE type. Total benefits ranged from \$49 million for 200 MW of wind in the Upper Midwest, to \$6.5 million for 200 MW of wind in California; utility-scale solar ranged from \$23 million in the Mid-Atlantic to \$8.6 million in California; benefits of rooftop solar ranged from \$20 million in the Mid-Atlantic to \$7 million in California.

## **001.02.53. Towards a European Exposure Science Strategy 2030; Bridging the Science and Regulatory Frameworks in Europe**

Yuri Bruinen de Bruin

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Abstract: A diverse range of European Union legislation, including REACH, the biocides Regulation, the Sustainable Use of Pesticide Directive, the General Food Law, the Regulation on Medical devices and Construction Products, puts a unique demand on the European exposure science community. In 2017, the European branch of ISES, called ISES Europe, was officially founded promoting the establishment of a highly needed European exposure platform. ISES Europe aims at the integration of exposure science into European regulations and industry practice, and to anchor it in academic research and education, in order to foster innovation and to create a safe and sustainable future for humans and the environment. One of the immediate actions of ISES Europe was to start building a European Exposure Science Strategy with a roadmap 2020 - 2025 - 2030, jointly with all stakeholders that use exposure science in Europe. From 19-20th of June, ISES Europe held its first workshop in Dortmund, Germany, to stimulate discussion and cooperation among ISES Europe members and to encourage the establishment of working groups, building and implementing the Strategy. The Workshop was held along six overarching exposure science themes being 1. data repositories and analytics; 2. regulatory exposure assessment science; 3. building partnerships and collaboration, 4. exposure data production and monitoring; 5. exposure assessment methods and tools; and 6. exposure education and communication. During this presentation the outcomes of the Workshop will be presented including the key indicators of exposure science in Europe along with the state of the art, current scientific developments, important actors, respective boundary conditions and strategies how different sectors and institutions can work together to promote exposure science developments in Europe via partnerships and working groups.

S01.02A. Advances in Air Pollution Exposure Assessment for Population Health Studies in Low and Middle Income Countries: Insights from India and Beyond

**S01.02.01. Pure-Air: A Global Assessment of Household and Outdoor Air Pollution and Cardiopulmonary Disease**

Michael Brauer

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Abstract: We are adding an air pollution study (PURE-AIR) to the ongoing prospective urban and rural epidemiological (PURE) cohort, which includes ~225,000 adults aged 35-70 years living in 850 communities in 27 countries. Here, we will describe the comprehensive methods used to estimate outdoor, household and personal air pollution exposures. Outdoor estimates include PM<sub>2.5</sub>, from an existing 1x1km satellite surface, and NO<sub>2</sub>, from a newly created global LUR model. In addition, we are measuring PM<sub>2.5</sub> for 48-hr periods using the UPAS monitor in ~4,500 households and concurrently for ~1,200 individuals. Individuals also wear a silicon wristband to capture organic exposures. To-date we have collected data for 1,400 households and 300 individuals. Data collection will continue for the next 18 months. Preliminary outdoor, household and individual exposure assessment results will be presented and future plans for epidemiological analyses.

## **S01.02.02. Particle Exposure Assessment in Peri-Urban India: Lessons Learned from the CHAI Project**

Cathryn Tonne

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**Abstract:** As part of the CHAI project investigating particle exposure in relation to intermediate cardiovascular outcomes, we modeled four estimates of exposure for a cohort in peri-urban South India. Participants (n~6000) reside in 28 villages with a total area of 8.2km<sup>2</sup> southeast of Hyderabad. Gravimetric 24-hr personal exposure to PM<sub>2.5</sub> and BC was measured on 400 individuals on two occasions; these data were used to develop prediction models of personal exposure for the cohort. Ambient PM<sub>2.5</sub> and BC were measured throughout the study area (21 days, two seasons); these data were used to develop land-use regression (LUR) models of long-term exposure outdoor at residence. Time resolved personal PM<sub>2.5</sub> measurements paired with GPS and wearable cameras were collected on a nested panel (n=40 individuals, six measurement-days). This presentation highlights lessons learned. We compare approaches for estimating exposure and how these estimates compare with more detailed measurements from the panel study. Our results support the potential of predicting personal exposure with high-density time activity data derived from wearable cameras, which is currently feasible only on a relatively small number of participants. Models predicting personal exposure for the full cohort using more limited questionnaire data had moderate performance and showed substantial differences by sex. Distributions of predicted personal exposure were substantially different from exposure estimated by LUR, although agreement was higher in some subgroups. The presentation covers particular challenges in this setting; for example, high within-person (82% men; 78% women PM<sub>2.5</sub>) compared to between-person variability in measured personal exposure. CHAI is a useful example of dense data collection and modeling at the local-scale that can be juxtaposed against larger-scale studies.

### **S01.02.03. Optimizing Air Pollution Exposure Assessment Methods for Pregnant Women: Experiences from the Rural-Urban TAPHE Cohort in Tamil Nadu, India**

Kalpana Balakrishnan

*Kalpana Balakrishnan<sup>1</sup>, Santu Ghosh<sup>2</sup>, Sankar Sambandam<sup>1</sup>, Krishnendu Mukhopadhyay<sup>1</sup>, Naveen Puttaswamy<sup>1</sup>, Thangavel Gurusamy<sup>1</sup>*

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**Abstract:** Background PM<sub>2.5</sub> exposures related to ambient and household air pollution can impact birthweight, but evidence from India is limited. Lack of routinely collected ambient PM<sub>2.5</sub> data and the challenges of conducting personal exposure measurements on pregnant women make it difficult to quantify exposure-response relationships. We report results from the Tamil Nadu Air Pollution and Health Effects(TAPHE) study that developed alternative approaches to estimate pregnancy period exposures for application in exposure-response analyses. **Methods** We followed 1121(602 rural and 519 urban) pregnant women from first trimester until birth to collect exposure and health data. We performed 24-hr kitchen area measurements to cover every trimester and/or season during pregnancy(n=1349) together with living area (n=1164), near household outdoor (n=377) and personal exposure (n=65) measurements in a subset and time-activity recalls at the end of each monitoring period. **Results** The average 24 hr concentrations of PM<sub>2.5</sub> in the kitchen, living and near household outdoor areas were 108.8 µg/m<sup>3</sup>; 65.8 µg/m<sup>3</sup>; and 108 µg/m<sup>3</sup> in rural and 66.3 µg/m<sup>3</sup>; 57.8 µg/m<sup>3</sup> and 57.9µg/m<sup>3</sup> in urban households respectively. The kitchen, living and near outdoor micro-environments contributed to 30%, 54% and 14% of measured personal exposures (adj.r<sup>2</sup>= 82%; ρ= .64 for correlation between measured and time-weighted personal exposures) respectively. This is consistent with time activity profiles, which estimate pregnant women spending ~18-20 hrs indoors. **Conclusion** Indoor PM<sub>2.5</sub> concentrations, from indoor combustion sources but also likely outdoor penetration, contributed the most to PM<sub>2.5</sub> exposure for pregnant women and could serve as a reliable proxy for personal exposures in air pollution and birthweight related exposure-response analyses in India. The recent development of low cost, continuous monitoring PM<sub>2.5</sub> sensors will allow long-term area monitoring to address exposure mis-classification in future studies.

#### **S01.02.04. Towards a National Scale Spatio-Temporal Model for Ambient PM2.5 in India**

Joel Schwartz

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Abstract: We report the results of a nation-wide effort to develop a PM2.5 model on a fine spatial and temporal resolution. We will combine WRF-Chem estimates of particle concentrations on a finer spatial scale than GEOS-Chem, updated fire emissions inventories, satellite remote sensing AOD data on a 1 km grid, land use data, and weather data (including PBL height) and train on ground based monitoring using multiple machine learning techniques. Parameter choices will be made using 10-fold cross validation. PM10 data was converted into PM2.5 using a support vector machine on collocated monitors. Nearby monitoring is included as a predictor and missing AOD values will be filled in so that predictions are available for all days and locations. Final models are ensemble weighted averages of the individual models: support vector machine, neural network, gradient boosting, and random forests). Within grid cell land use regression for address specific estimates are done similarly on monitor deviations from cell averages. In preliminary analyses for the greater Dehli area, we find cross validated R2 for annual average PM2.5 of greater than 0.91 except for one year (2011, CV R2=0.72).

### **S01.02.05. Spatiotemporal Prediction of Daily Average Ambient PM2.5 Concentrations at 1 Sq. Km. Grids over Delhi, India, from 2010 to 2016 Using Ensemble Models**

Siddhartha Mandal

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**Abstract:** Introduction: Ambient air pollution in India, with high concentrations of particulate matter, is a major public health hazard. However, detailed spatiotemporal PM2.5 exposure assessment is lacking in India. We modeled daily average ambient PM2.5 concentrations at 1 sq.km. grids in Delhi from 2010-2016, using multiple data sources and ensemble modeling approaches. Methods: A multi-stage modeling was implemented using satellite data, land use data, reanalysis based meteorology and population density. A calibration regression was used to model PM2.5:PM10 to counter the sparsity of ground monitoring data. Next, the relationship between PM2.5 and spatiotemporal predictors was modeled using learners such as gradient boosting models(GBM), support vector regression(SVR) and random forests(RF). Predictions from each learner were combined using a generalized additive model and finally, support vector regressions were used to smooth the spatiotemporal predictions. Results: Monthly median PM2.5 in Delhi ranged from 39-236 $\mu\text{g}/\text{m}^3$  with IQRs between 21-232 $\mu\text{g}/\text{m}^3$ . Average spatial variability across monitoring stations ranged between 21-191 $\mu\text{g}/\text{m}^3$ . Annual average PM2.5 concentrations have increased from 117 to 149 $\mu\text{g}/\text{m}^3$  across the study period. Cross-validated(CV)-R2 for the calibration regression ranged between 0.77 (fall) to 0.88 (monsoon). Average CV-R2 were 0.66(GBM), 0.60(SVR) and 0.67(RF) for the learners and 0.70 for the ensemble averaged (EA) model. Root mean squared errors (RMSE) for EA predictions were in the range 26-61 $\mu\text{g}/\text{m}^3$  with bias (slope of observed vs predicted) ranging between 0.96-1.18 across seasons. Spatial CV-R2 (yearly average) varied between 0.6-0.88, while temporal CV-R2 (daily variability) ranged from 0.52-0.73, across years, showing adequate model performances. Conclusion: Spatiotemporal estimates of PM2.5 concentrations provide comprehensive assessment in high exposure settings and will be used to study the impact of PM2.5 on long and short term health outcomes.

## S01.02B. High-Resolution Metabolomics: A Platform Linking the External and Internal Environment

### S01.02.07. Recent Technical Advancement in High-Resolution Metabolomics

Dean Jones

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Abstract: Metabolomics refers to the study of small molecules in biologic systems. Earlier technologies were restricted in sensitivity and only detected hundreds of chemicals, but contemporary ultra-high-resolution mass spectrometry coupled to liquid chromatography, gas chromatography and other separation techniques, show that the metabolome of humans and other species consists of hundreds of thousands of chemicals derived from endogenous metabolism, food, microbial symbionts and infectious agents, and chemicals from environmental exposures. Coupling exposure science measures of exogenous chemicals with high-resolution metabolomics (HRM) for biomonitoring of environmental chemicals and metabolites has considerably facilitated interpretation of low abundance signals, which are often present at three to five orders of magnitude lower abundance than endogenous metabolites. Current HRM methods rely upon multiple technical replicates with advanced instrumentation for separation, ionization and detection, along with data extraction and computational methods. Fourier-transform instruments (e.g., orbitrap MS, Ion-Cyclotron Resonance MS) enable measurement of tens of thousands of chemicals with accurate mass  $m/z$  within 5 ppm mass resolution and mass accuracy. Computational methods and big data tools are being used to curate this extensive number of low abundance signals and connect these chemical signals to metabolic responses, biomarkers of risk and impacts on disease phenotype.

## **S01.02.08. Metabolome Wide Association Study and the Exposome: Linking Exposure to Internal Dose, Biological Response and Disease**

Douglas Walker

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**Abstract:** The metabolic phenotype provides a central measure linking exposure to internal dose, biological response and disease. Use in molecular and environmental epidemiology studies demonstrate application of metabolomic techniques for new insight into how environment contributes to disease; however, key data analyses issues include the need to protect against false discovery, the use of unidentified measures in analysis and strategies to link multiple significant features into common conceptual models for interpretation. In this presentation, we will demonstrate how biological network inference can be applied through a metabolome-wide association framework to delineate exposure biological response in complex organisms and human populations. Applications will include a multi-platform, mass spectrometry-based approach providing in-depth coverage of the exposome and metabolome to characterize a *C. elegans* exposome model, a critically-ill population and patients with primary sclerosing cholangitis. Results from these studies show gas-chromatography with ultra-high resolution mass spectrometry (UHRMS) makes possible detection >75,000 molecular features in plasma, which includes >250 confirmed environmental pollutants. HRM by dual column liquid chromatography with UHRMS detects over 25,000 chemical signals that arise from core nutrient metabolism, lipids, the microbiome, diet-derived chemicals, pharmaceuticals and environmental contaminants, providing measures of biological response, metabolic health and toxicodynamics. Integration of these two platforms and identifying how network topology is associated with metabolic pathway enrichment allows identified and unidentified metabolic signals to be linked to underlying exposure and disease pathobiology. Combined with complementary OMIC measures, such as gene expression, epigenetic and proteomic changes, now makes possible a systems-biology understanding of chemical toxicology and environmental health in humans.

## **S01.02.09. Metabolic Changes Associated with Exposure to Perfluoroalkyl Substances in Women**

Vincent Bessonneau

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Abstract: Recent epidemiological studies suggest that human exposure to perfluoroalkyl substances (PFAS) may affect metabolic function, inflammation and immunity. To gain further insight about biological effects of PFAS exposures, we explored associations between PFAS and the serum metabolome in adult women. In a cohort of 160 women workers, including firefighters and office workers, from California, we investigated associations of serum PFAS exposures - quantified by liquid-chromatography and tandem mass spectrometry (LC-MS/MS) - with metabolites identified using non-targeted metabolomics analysis using LC combined to time-of-flight mass spectrometry (LC-QTOF/MS) through linear regressions models. After adjusting for age, race/ethnicity, BMI, income and occupation and correcting for multiple hypothesis testing (False Discovery Rate  $\leq 10\%$ ), we observed that several oxylipins, bile acids (BA), steroid hormones and fatty acids were significantly associated with exposures to PFBuS, PFHxS, PFNA, and PFDA, suggesting that exposure to PFAS may contribute to chronic inflammation. To test this hypothesis, we used National Health and Nutrition Examination Survey (NHANES) data to quantify the relationships between serum PFAS and C-reactive protein (CRP) - a well-established marker of inflammation - in adult women, adjusting for age, race/ethnicity, poverty, BMI, and serum cotinine. We found that each doubling in PFDA, EPAH, PFNA, PFOS and PFDoA was positively associated with an increase in serum CRP, confirming some of the metabolomics findings. This study suggests that non-targeted metabolomics is a powerful approach to generate testable hypotheses about possible health effects related to chemical exposures and explore the underlying mechanisms that mediate these relationships.

## S01.02.10. High-Resolution Metabolomics Study of Occupational Exposure to Trichloroethylene

Nathaniel Rothman

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**Abstract:** Introduction: Trichloroethylene (TCE) is a common water contaminant and continues to be used in the workplaces of many developing countries. It causes kidney cancer and possibly non-Hodgkin lymphoma and liver cancer. However, the underlying pathophysiology of TCE-induced cancer is not well understood. To evaluate biological responses to TCE, we conducted a cross-sectional molecular epidemiology study of workers exposed to TCE and unexposed controls and applied non-targeted metabolomics analysis. Methods: We studied 80 healthy workers that used TCE and 95 comparable unexposed controls in Guangdong, China. The TCE-exposed workers had a median 8-hour time weighted average personal air exposure of 12 ppm (range: 0.4 to 230 ppm), with almost all workers having exposure under the current U.S. OSHA Permissible Exposure Limit of 100 ppm. Metabolomics analysis of plasma samples was conducted by ultra-high resolution mass spectrometry Results: Metabolic features associated with TCE exposure included known TCE metabolites and additional unidentified chlorinated compounds. TCE exposure was also associated with multiple alterations in endogenous metabolism, including changes in purine catabolism and decreases in sulphur amino acid and bile acid biosynthesis pathways. Specific metabolite associations with TCE exposure included uric acid, glutamine, cystine, methylthioadenosine, taurine and chenodeoxycholic acid, consistent with immunosuppressive, hepatotoxic and nephrotoxic effects that have been related to TCE. There were also correlations between multiple metabolites and additional exposure, immunologic, and nephrotoxic biomarkers that had been measured previously. Conclusion: Untargeted high-resolution metabolomics correlated occupational exposure to TCE with internal dose and metabolic responses, providing new insights into molecular mechanisms of TCE-related disease.

### **S01.02.11. Prospective Study of Untargeted Urinary Metabolomics and Risk of Lung Cancer among Never-Smoking Women in Shanghai, China**

Qing Lan

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**Abstract:** Background: Never-smoking Chinese women have a high rate of lung cancer but the etiology is poorly understood. This study is the first to evaluate the untargeted urinary metabolome and risk of lung cancer among never-smoking women in China. Methods: This nested case-control study included 275 never-smoking lung cancer cases and 289 never-smoking controls from a prospective cohort, the Shanghai Women's Health Study, comprising 73,363 Chinese women. Metabolic profiling of urinary chemical features was conducted using ultrahigh-performance liquid chromatography - tandem mass spectrometry (UPLC-MS) and nuclear magnetic resonance spectroscopy. Unconditional logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for the association between each log-transformed metabolite and lung cancer risk, after adjusting for potential confounders. Linear regression was used to estimate associations between the most significant metabolites and dietary factors. Results: Initial analyses found that three UPLC-MS detected urinary metabolites were negatively associated with lung cancer risk with a false discovery rate < 10%: pos\_2.61\_127.0382m/z, neg\_2.60\_369.0408m/z, and pos\_2.61\_184.0325n, which were strongly correlated with each other. The most statistically significant metabolite (pos\_2.61\_127.0382m/z, P = 1.98 x 10<sup>-6</sup>) was identified as 5-methyl-2-furoic acid and was moderately correlated with self-reported usual dietary intake of soy. Increasing tertiles of the metabolite level were significantly associated with reduced lung cancer risk (OR (95%CI): 1.00, 0.52 (0.34-0.80), 0.46 (0.30-0.70, respectively); P-trend = 1.81 x 10<sup>-4</sup>). Conclusions: Our findings suggest that soy foods have a protective effect on lung cancer risk in this population of never-smoking women, and are consistent with a previous report from this cohort using questionnaire-based estimates of soy intake. Further studies are needed to replicate and extend the findings.

## **S01.02.12. Changes in the Blood Metabolome in Relation to 24hr Personal Air Pollution Exposure Measurements: A Panel Study in Four European Countries**

Roel Vermeulen

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**Abstract:** Background: The peripheral blood might harbor compounds originating from air pollutants and endogenous metabolites influenced by air pollution. Within the Exposomics project high resolution metabolomics was explored as a tool to detect air pollution related changes in metabolic pathways occurring in peripheral blood. Methods: One of the Exposomics studies was a study among a panel of 157 healthy non-smoking adults living in four European cities. We collected three 24-hour personal and ambient exposure measurements of particulate matter (PM<sub>2.5</sub>), PM<sub>2.5</sub> absorbance, and ultrafine particles. Peripheral blood samples were collected in the morning after each exposure measurement and were used for metabolomic profiling by mass spectrometry. All blood samples were analyzed in a single laboratory. We applied univariate mixed-effects models, corrected for multiple testing, to investigate the association between air pollution and high resolution metabolomics. Results: In preliminary analyses we identified associations between the personal measurements of air pollution, including ultrafine particles, with 10 metabolic features at a false discovery rate (FDR) of 5% and with 2029 features at a FDR of 20%. We observed overlap between air pollutants with regards to the associated features. Annotation of the identified features is ongoing. Conclusion: In this study we observed evidence for a potential impact of short term variation in air pollution on metabolic changes in peripheral blood. Considerable between-city differences were observed in both air pollution levels and the metabolome, complicating the identification of those features that are unique to air pollution. We are currently applying a bioinformatics approaches to acquire insight into putatively affected metabolic pathways.

S01.02C. Investigating Chemical Constituents and Exposure Potential in Recycled Tire Crumb Rubber Infill Used in Playing Fields and Playgrounds: State, Federal, and International Governmental Perspectives

**S01.02.13. California Synthetic Turf Study**

Randy Maddalena

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Abstract: There are over 900 synthetic turf sport fields in California (CA). Public concern about cancer incidents among young athletes, especially soccer goalies, has increased in recent years. The Office of Environmental Health Hazard Assessment of the California Environmental Protection Agency has launched a 4-year environmental health study of the potential health effects associated with synthetic turf fields and playground mats containing recycled tires (i.e., crumb rubber). The aims of the study are to: 1) identify and characterize chemicals and particles released from these fields and playgrounds; 2) evaluate potential human exposures during use of such fields or playgrounds; and 3) assess human health risk from the exposures. The chemical/particle characterization included preinstalled crumb rubber from recyclers, installed crumb rubber from fields, concentrations in air above fields, and targeted laboratory chamber tests. Crumb rubber was sampled from four CA recyclers for initial chemical characterization. A stratified random sampling scheme was applied to recruit fields in various climate regions across CA where infield crumb was sampled. A subset of the fields (n = 35) were included in the detailed environmental exposure testing with both on-field and off-field monitoring. Players performed scripted soccer activities near the on-field monitoring area and testing was conducted both with and without activity on the field. Monitoring was conducted at 1 off-field location and 3 on-field locations near (and downwind from) the active zone and at up to 5 elevations above the field. Monitoring included particulate matter (PM) measurements (number of particles ranging 7 nm to 20 µm; mass of PM<sub>2.5</sub> and PM<sub>10</sub>), metals, volatile and semi-volatile organic chemicals, ozone, temperature (subsurface, surface and above the field), light intensity, humidity and wind speed/direction. This presentation will describe the study protocol and summarize the preliminary data.

## **S01.02.14. Toxicological Research to Assess Bioaccessibility and Biological Effects of Recycled Tire Crumb Rubber Using In Vitro and In Vivo Testing Approaches**

Georgia Roberts

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**Abstract:** The National Toxicology Program conducted in vitro and 14-day in vivo studies of tire crumb rubber (TCR) to enhance understanding of potential health impacts of exposure to chemicals released from TCR, and to evaluate (1) utility of different experimental models for characterizing toxicity, (2) routes of exposure that may result in systemic exposure, and (3) bioaccessibility of TCR constituents. Multiple lots of fresh recycled TCR were received from California EPA and combined into one test lot for use in these studies. The lot was characterized using microscopy, elemental composition, metal analysis, as well as liquid (LC-MS) or gas chromatography coupled with mass spectrometry. In vitro studies were conducted with human-derived skin, lung, small intestinal and liver cell lines using TCR-conditioned media (TCR-CM). TCR was incubated in cell type-specific culture media for different durations and temperatures followed by sterile filtering to generate TCR-CM for cell exposures. Cytotoxicity was observed with all cell lines, except liver, which was dependent upon concentration as well as the duration and temperature of media conditioning with TCR. Conversely, TCR incubated in PBS or artificial lung fluid was not cytotoxic. Untargeted LC-MS was used to characterize the chemical composition of TCR-CM. In vivo 14-day studies in female B6C3F1/N mice were conducted by administering size-fractionated TCR by oral gavage, dosed-feed or by housing on TCR mixed-bedding. Traditional measures of toxicology testing were evaluated and showed no toxicologically relevant changes by the routes tested. Using a LC-MS metabolomics analysis approach, urine and plasma were evaluated for evidence of exposure. Principle component analysis of untargeted data was unable to differentiate treated and control groups, likely due to low exposure levels and high interanimal variability. Compounds potentially originating from TCR were tentatively identified in urine and plasma from gavage animals.

## **S01.02.15. Moving from a Human Health Risk Assessment of Playing Sports on Rubber Granule Infill in the Netherlands to a Restriction Proposal for Polyaromic Hydrocarbon Content in Rubber Granules in the European Union**

Wouter ter Burg

*Wouter ter Burg*<sup>1</sup>

*1. RIVM, Bilthoven, Netherlands.*

Abstract: The Dutch National Institute for Public Health and the Environment (RIVM) evaluated the health risk of playing sports on synthetic turf pitches with rubber granule infill. To evaluate the health risks of playing sports on rubber granules, it is important to determine which hazardous substances are contained in the granule and to what extent they may be released. Subsequently, it was examined how people playing sports can come into contact with these substances and whether this can lead to health effects. RIVM determined the substances in rubber granule from 100 sports pitches that are representative of the synthetic turf pitches in the Netherlands. The institute further performed three types of laboratory tests to examine the release of substances from the granules, so-called 'migration studies'. In addition, RIVM studied the information available in the scientific literature on substances in rubber granules, their properties and their health effects. The risks for football players were considered virtually negligible, which was later also confirmed by an analyses made by the European Chemicals Agency (ECHA, 2017). However, the current limit values for 'mixtures' supplied to the general public apply to the rubber granules and these limits do not guarantee that risks are controlled. Therefore, the Netherlands in cooperation with ECHA is preparing a restriction dossier. In the restriction dossier under REACH the scope is extended to include exposure of workers (installation and maintenance) and of children at playgrounds with focus on the main driver for risks, i.e. the polyaromatic hydrocarbons (PAHs). Rubber mulches (flakes) may also be used in loose form on playground and these are included in the dossier as well. The restriction proposal submitted by the Netherlands aims at a significantly lower content limit of PAHs in rubber granules, thereby following up on RIVM's recommendation back in 2017.

## **S01.02.16. European Chemical Agency's Perspective: An Evaluation of the Possible Health Risks of Recycle Rubber Granules Used as Infill in Synthetic Turf Fields**

Andreas Ahrens

*Andreas Ahrens<sup>1</sup>*

*1. Registration Directorate, European Chemicals Agency, Helsinki, Finland.*

Abstract: Concerns have been raised in the European Union (EU) whether substances in infill material in synthetic turf fields are causing health risks to players of football (soccer) and other sports. It is estimated that by 2020 there will be 21 000 full size pitches and 72 000 so-called mini-pitches installed in the EU. Most of the infill material used on synthetic turfs is from recycled tyres. ECHA assessed risks of certain prioritised substances to children, professional players, and workers installing or maintaining the fields. The European Chemicals Agency (ECHA) conducted a preliminary evaluation and published its report in February 2017. ECHA did not find a reason to advise people against playing sports on synthetic turfs containing recycled rubber granules as infill material. Exposure to substances assessed caused a very low level of concern, specifically with regard to excess lifetime cancer risk. However, ECHA listed several uncertainties, including the representativeness of the analysed samples and whether other substances were of concern. ECHA made recommendations to take into account the remaining uncertainties, such as the potential need for a restriction to ensure all players on relevant fields have a very low level of concern. This recommendation and their own study led the Netherlands to begin the preparation of a REACH restriction proposal to limit the concentration of polycyclic aromatic hydrocarbons in infill material. The proposal will be evaluated by ECHA's scientific committees for Risk Assessment (RAC) and for Socio-economic Analysis (SEAC) as to whether the proposed restriction would suitably reduce the identified risks and whether the benefits of doing so would outweigh the costs. Based on the opinions, the European Commission, after consulting with the Member States, will then adopt the restriction. Furthermore, the European Commission requested ECHA to also look into the other substances contained in the rubber granules that may be a risk to health.

## **S01.02.17. Perspective from the United States (U.S.) Federal Research Action Plan (FRAP) on Recycled Tire Crumb Rubber Used on Synthetic Turf Playing Fields and Playgrounds**

Annette Guiseppi-Elie

*Annette Guiseppi-Elie<sup>1</sup>*

*1. National Exposure Research Laboratory, US EPA, Durham, NC, United States.*

Abstract: Concerns have been raised by the public, both nationally and internationally, about the safety of recycled tire crumb rubber used in synthetic turf fields and playgrounds. Previous studies have not, in general, provided evidence of adverse health outcomes resulting from exposures to tire crumb rubber infill at synthetic turf fields. Most of the existing published studies were limited in scope and sample size and did not comprehensively evaluate all aspects of exposure associated with the many use scenarios. However, several recent research studies have been initiated to address these limitations, including a recently completed study in the United States that is the basis for this perspective. In 2016, US federal Agencies, specifically, the U.S. Environmental Protection Agency (EPA), the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC/ATSDR), and the U.S. Consumer Product Safety Commission (CPSC) launched the Federal Research Action Plan (FRAP) on Recycled Tire Crumb Rubber Used on Synthetic Turf Playing Fields and Playgrounds. CDC/ATSDR and EPA implemented a comprehensive tire crumb rubber characterization study and a pilot-scale exposure characterization study and exposure measurements sub-study that are key components of the study. CPSC plans to use field observations, focus groups, and a national survey of parents and childcare providers to collect information on children's behaviors on playgrounds to identify exposure factors. The presentation will provide insights into completed aspects of the study, including the tire crumb characterization and pilot exposure assessment that are relevant for advancing our knowledge to address potential exposures to tire-derived materials on synthetic turf fields and playgrounds. Also, the presentation will provide a US perspective on the value of this coordinated effort, especially as it relates to other recent research activities globally.

## **S01.02.18. Investigating Chemical Constituents and Exposure Potential in Recycled Tire Crumb Rubber Infill Used in Playing Fields and Playgrounds: State, Federal, and International Governmental Perspectives**

Annette Guiseppi-Elie

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- 4. National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands.*
- 5. European Chemical Agency (ECHA), Helsinki, Finland.*

Abstract: Concerns have been raised by the public, both nationally and internationally, about the safety of recycled tire crumb rubber used in synthetic turf fields and playgrounds. Previous studies have not, in general, provided evidence of adverse health outcomes resulting from exposures to tire crumb rubber infill at synthetic turf fields. Most of the existing published studies were limited in scope and sample size and did not comprehensively evaluate all aspects of exposure associated with the many use scenarios. However, several recent research studies have been initiated to address these limitations. This session will include participation from a variety of international governmental researchers. We will use a presentation/panel format where the different speakers will provide opening statements (limited to 15 minutes) on their study perspectives followed by this roundtable discussion where participants will discuss insights gained from each study (guided by a set defined topic areas). The robust discussion should provide valuable information in a global context to attendees on the broad topics of potential exposures and impacts of tire-derived materials used on synthetic turf fields and playgrounds.

## S01.02D. Sound Off for Environmental Noise Research: Milestones in Exposure Assessment and Health Evidence

### **S01.02.19. Noise Exposure Assessment in Europe: Current and Future Challenges**

John Gulliver

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*1. Centre for Environmental Health and Sustainability, University of Leicester, Leicester, United Kingdom.*

Abstract: Proprietary software (e.g. CadnaA, SoundPlan,) has long served the needs of undertaking noise assessments for road traffic, railway traffic, aircraft, and industrial noise in Europe as part of strategic noise mapping and exposure studies. The Common Noise Assessment Methods in EU (CNOSSOS-EU), in accordance with the Environmental Noise Directive (END), aims to improve the consistency and comparability of noise assessment results across the EU Member States; CNOSSOS-EU has recently been implemented in software. CNOSSOS-EU also provides an opportunity in international-scale cohort studies for harmonizing exposure assessments, but it brings the challenge, especially for pervasive noise sources such as road traffic, of having detailed information on source emissions over large geographical areas to produce noise estimates at potentially millions of address locations. Open-source road traffic models, including CNOSSOS-EU, have recently been developed with some simplifications to the emissions and propagation models to facilitate exposure assessments in large-scale studies. An overview of the state-of-the-art in noise modelling for exposure studies will be given, including land use regression (LUR) models for noise. Although performance has been shown to be promising (e.g.  $R^2 \sim 0.6-0.8$ ), and in some instances comparable with deterministic noise models, LUR requires spatially distributed noise measurements for model development which are not routinely available. One possibility to assist the adoption of LUR is repeated short-term noise measurements. Examples will be given that compare the performance of LUR with CNOSSOS-EU where spatially dense networks of short-term noise measurements are available. These examples will also show how recent developments to improve the granularity of traffic information on minor roads affects the performance of noise models and distributions of exposures for cohorts.

## **S01.02.20. Noise Exposure Assessment in North America: Past Challenges and Future Opportunities**

Sara Adar

*Sara Adar<sup>1</sup>*

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Abstract: Neighborhood noise has been linked to chronic health problems across the life-course, ranging from cognitive and sleep disturbances in children to hypertension and cardiovascular disease in adults. Although noise is a ubiquitous hazard in North America, its population burden has historically not been well characterized due to a lack of exposure estimates. Recently, however, two national prediction models became available for the US: one deterministic model of transportation noise and another empirical model of total (i.e., anthropogenic and natural) noise. While these models may create opportunities for epidemiology, their predictive performance has not been rigorously assessed, especially in complex urban landscapes. This talk presents the results of a validation study of the new US noise models based on nearly 600 daytime, non-rush hour noise measurements collected in one Western, Midwestern, and Eastern city. Predicted transportation (51, 48, 54 dB) and total (51, 55, 55 dB) noise levels were consistently lower than measured levels (63, 61, 74 dB) in Seattle (n=138), Chicago (n=182), and New York City (n=267), respectively. The within-city variability of measured noise levels (SD: 6-7dB; Coefficient of Variation (CV): 9-12%) was similar to that of predicted transportation noise (SD: 6-8 dB; CV: 12-17%) but larger than total predicted noise (SD: 2-3 dB; CV: 4-5%). Both models performed best in Seattle with out-of-sample R<sup>2</sup>s of 0.6 and 0.2 for the transportation and total noise models, respectively. There was poorer predictive performance in Chicago and New York (R<sup>2</sup>s: 0.2 and 0.1 for transportation noise and 0.0 and 0.1 for total noise). Using 20-50 additional measurements collected per city during rush hour, we found R<sup>2</sup>s of similar magnitude (0.0-0.5) though the performance varied by site and model. These findings suggest that the predictive performance of noise models should be carefully considered by location and time when planning future epidemiological research.

## **S01.02.21. Noise and Health in Pregnancy and Birth Outcomes**

Anna Hansell

*Anna Hansell<sup>1</sup>*

*1. Centre for Environmental Health and Sustainability, University of Leicester, Leicester, United Kingdom.*

Abstract: The most recent systematic review of environmental noise and birth outcomes is by Nieuwenhuijsen et al, 2017. It considered 14 studies published up to December 2016 - six aircraft, five road traffic, three total ambient (mainly road) noise. Associations with road traffic noise and low birth weight, preterm birth, and small for gestational age were considered 'low quality' evidence using GRADE criteria (further research is very likely to have an important impact on confidence in the estimate of effect and to change the estimate); while aircraft noise and low birth weight, preterm birth and congenital anomalies was considered 'very low quality' evidence (any estimate of effect is very uncertain). A suite of studies published in 2017 from the Danish national birth cohort considered road traffic noise (Lden) in 1996-2002 for up to 80,000 pregnancies. No significant associations were observed with birth weight, size at birth or congenital anomalies. A study of ~540,000 births in London 2006-10 (Smith, 2017) found no overall associations with road noise after adjusting for air pollutants, but some persisted in highest exposure categories (>65dB Lnight). A French study of ~1500 pregnancies found no association between road noise 2005-9 and preterm birth (Baba-Vasseur, 2017). There are very few studies considering maternal health. In the Danish birth cohort analyses, a 10 dB increase in road noise was associated with increased risk of short- but not long-term increases in time to pregnancy. Positive associations were also seen for hypertensive diseases of pregnancy, but these lost significance after adjustment for air pollution. A study in Korea of 18,165 pregnant women (Min & Min 2017), found an association between night-time aircraft noise during the first trimester of pregnancy and risk of gestational diabetes mellitus. In conclusion, despite a number of recent large studies, the evidence base relating to impacts of environmental noise in pregnancy remains limited.

## **S01.02.22. Noise, Sleep and Health Consequences**

Gunn Marit Aasvang

*Gunn Marit Aasvang<sup>1</sup>*

*1. Department of Air pollution and Noise, Norwegian Institute of Public Health, Oslo, Norway.*

Abstract: There is growing evidence that traffic noise has adverse long-term consequences for health. The recent systematic review commissioned by the WHO revealed increasing evidence for an association between traffic noise and cardiovascular disease, and some evidence for negative impacts on metabolic outcomes such as diabetes and obesity (van Kempen et al., 2018). Proposed mechanisms for these associations have focused on the general stress theory, as well as the impact on sleep as a possible mediator. Sufficient sleep is a prerequisite for good mental and physical health. The most recent systematic review of environmental noise and effects on sleep (Basner and McGuire, 2018) considered the associations with both immediate physiological effects of noise, as well as on self-reported sleep. The quality of evidence according to GRADE criteria, was considered as moderate for cortical awakenings and self-reported sleep disturbance due to traffic noise. For other noise sources, and for other measures of sleep the evidence was of lower quality. In this symposium, an overview of the short- and long-term effects of noise on sleep will be presented. Furthermore, the possible mediating role of sleep on the association between noise and health will be discussed in light of current knowledge, with special emphasis on cognitive and cardiovascular health. References Basner, M. and S. McGuire. WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. *International Journal of Environmental Research and Public Health*, 2018. 15(3): p. 519. van Kempen, E., et al. WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Cardiovascular and Metabolic Effects: A Summary. *International Journal of Environmental Research and Public Health*, 2018. 15(2): p. 379.

## **S01.02.23. Transportation Noise and Cardio-Metabolic Disease**

Hugh W Davies

*Hugh W Davies<sup>1</sup>*

*1. UBC, Vancouver, BC, Canada.*

Abstract: The link between noise and cardiovascular disease was among the earliest to be examined by researchers interested in the non-auditory effects of noise. While the earliest studies (pre-1980) suffered many limitations, they motivated a body of research in the 1980's and 90's that produced more consistent and increasingly valid findings relating transportation noise and CVD, and produced a biological model. Since then, a number of higher quality studies have probed the roles of different noise sources, and a greater range of outcomes. There is good evidence that noise is an independent risk factor for disease when co-exposure with air pollutants occurs. Increasingly studies have looked at the "intermediate" and other effects of noise in the cardio-metabolic pathway predicted by the model. Still the amount of research being done in this area is relatively low. A 2018 systematic review by the group updating the Environmental Noise Guidelines for the European Region (van Kempen, Cara, Pershagen and Foraster) reviewed evidence for an association between noise and cardiovascular and metabolic effects. They concluded that the most comprehensive evidence was available for road traffic and ischemic heart disease; a meta-analysis of 7 longitudinal studies gave a relative risk of 1.08 (95% CI 1.01-1.15) per 10 dB(LDEN). The most common outcome studied was hypertension but the authors rated the overall quality of evidence "very low". Other outcomes that have been examined include stroke, adiposity, obesity and diabetes. For these outcomes there are much fewer studies; those that exist are of variable quality and their findings are often inconsistent. Nevertheless, there is a plausible biological model linking noise with highly prevalent chronic disease outcomes in humans, so there is a great need for more studies and studies of stronger study designs, e.g. longitudinal, with improved exposure assessment and better control of potential confounding and other biases.

## 001.03A. A Closer Look At Exposures to Flame Retardants

### **001.03.01. Prioritization of Flame Retardants for Human Risk Evaluation Based on Population Levels and Toxicity**

Lisa Melymuk

*Lisa Melymuk<sup>1</sup>, Lola Bajard<sup>1</sup>, Ludek Blaha<sup>1</sup>, Jana Klanova<sup>1</sup>*

*1. Research Centre for Toxic Compounds in the Environment, Masaryk University, Brno, Czechia.*

Abstract: Due to flammability standards, flame retardants (FRs) are widely used in consumer products and building materials. International restrictions on the use of polybrominated diphenyl ethers (PBDEs) have led to their replacement by a plethora of alternative brominated (BFR), chlorinated (CFR) and organophosphate ester (OPE) FRs. PBDEs are broadly detected in human biomonitoring studies, indicating widespread population exposure. However, their replacement by a much larger set of FRs has led to challenges due to a lack of knowledge about physicochemical properties, appropriate biomarkers of exposure, analytical methods, and toxicology. Over 200 FRs are in use today, with a wide range of structures, leading to challenges in how to feasibly evaluate human exposure and assess risk. Through the HBM4EU project (<https://www.hbm4eu.eu/>) we developed a strategy to prioritize FRs for human biomonitoring based on extensive literature review and analysis of exposure and toxicology data, which was then expanded to a broader set of FRs. FRs were categorized based on extent of information on (1) use, (2) human exposure and (3) toxicity. We then ranked the FRs with evidence of toxicity and widespread non-occupational exposure to support further HBM and toxicity evaluation. Of the >200 flame retardants considered, 12 OPEs were identified as having HBM data that suggests significant human exposure, and sufficient evidence of toxicity to warrant concern, including 3 chlorinated OPEs; similarly 1 CFR and 2 BFRs were prioritized based on the same criteria. A further 11 compounds (3 OPEs, 8 BFRs) were highlighted due to a lack of toxicological and HBM data. The structure of the proposed prioritization strategy is such that it can be more generally applied to other compound groups, as the proliferation of the number of chemicals in commerce and with potential for human exposure is not a phenomenon unique to the FRs, but is rather a universal phenomenon of the developments of modern society.

### **O01.03.02. A Study of Flame Retardants in Residential Furniture and Impact on Human Exposure and Flammability Control**

Marilyn Black

*Aika Davis<sup>1</sup>, Debra Harris<sup>2</sup>, Marilyn Black<sup>1</sup>*

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Abstract: In order to meet flammability requirements, chemical flame retardants (FRs) are often added to consumer products including furniture. In some cases, FR usage is being reduced through elimination or replacement with more benign alternatives. The health risks associated with organohalogen FRs are well documented; exposure to some FRs may lead to health concerns such as cancer, thyroid disruption, delayed mental and physical development, advanced puberty, and reduced fertility. This study examined and compared chemical exposure levels from daily usage and flammability characteristics of residential chair manufactured specifically for laboratory study. All chairs were constructed exactly the same except for the four different FR technologies applied: no FR; application of a textile fire barrier; use of polyurethane foam with an added organophosphorus FR; and use of polyurethane foam manufactured with a reactive FR. The chairs were first measured for VOC and SVOC emissions, inside an environmentally controlled chamber, for inhalation, ingestion, and dermal exposure levels. Following chemical studies, the chairs were burned in a controlled fire laboratory to measure flammability parameters. Results show differences in FR exposure and flammability performance among the different chair types. Added FRs were detected in some of the environmental samples during the environmental chamber exposure measurements. The fire barrier technology had the greatest impact in suppressing furniture combustion. With the amount of FRs added to the constructed chairs, the chemical FRs did not show a measurable fire suppression advantage over chairs without any FRs. The study also shows the presence of other chemicals that should be considered in evaluating chemical exposure risks. This study provides scientific data to assess chemical exposure risks and flammability from furniture. The results will contribute to policy discussion on flammability regulations and product safety.

### **O01.03.03. Exposure to Brominated and Organophosphate Ester Flame Retardants in U.S. Childcare Environments: Effect of Removal of Flame-Retarded Nap Mats on Indoor Levels**

Amina Salamova

*Amina Salamova<sup>1</sup>, William A. Stubbings<sup>1</sup>, Kevin Romanak<sup>1</sup>, Marta Venier<sup>1</sup>, Maia Thomas<sup>2</sup>, Erika Schreder<sup>2</sup>*

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**Abstract:** Nap mats are a significant item in childcare settings used for children naptime. Typically, they are one- to two-inch thick mattresses made of polyurethane foam encased in a vinyl cover. Childcares that serve young children in full-day programs generally use, and store, one nap mat for each child. For this study, we conducted an intervention, replacing flame-retarded nap mats with flame-retardant-free mats, and measured concentrations of flame retardants in indoor air and dust before and after replacement. Seven childcare centers in Seattle, USA, were recruited to participate in the study using the following criteria: regular use of nap mats, serving low-income families, and minimal presence of other foam-containing items. Foam from existing in-use nap mats from each center was analyzed to confirm the presence of flame retardants. Foam and fabric from replacement mats was also analyzed for flame retardants to identify flame-retardant-free products. Existing mats were replaced with flame-retardant-free mats or cots in six centers. The predominant FRs found in dust and indoor air were 2-ethylhexyl tetrabromobenzoate (EHTBB) and tris(1-chloro-2-propyl) phosphate (TCIPP), respectively. Naps mat samples analyzed from five of the seven centers contained a Firemaster<sup>®</sup> mixture, while one mat was predominantly treated with tris(1,3-dichloroisopropyl) phosphate (TDCIPP) and the other contained no detectable target FRs. After replacement, there was a significant decrease ( $p = 0.03-0.09$ ) in median dust concentrations for bis(2-ethylhexyl) tetrabromophthalate (BEHTBP), EHTBB, tris(4-butylphenyl) phosphate (TBPP), and TDCIPP with reductions of 90%, 79%, 65%, and 42%, respectively. These findings suggest that the nap mats were an important source of these FRs to dust in the investigated childcare environments and that a campaign of swapping out flame retarded mats for FR-free ones would reduce exposure to these chemicals.

#### **001.03.04. Temporal Trends in Serum Polybrominated Diphenyl Ether Concentrations in the Australian Population, 2002-2013**

Lesia Aylward

*Leisa-Maree Toms<sup>1</sup>, Andreas Sjodin<sup>2</sup>, Peter Hobson<sup>3</sup>, Fiona Harden<sup>4</sup>, Lesia Aylward<sup>5</sup>, Jochen Mueller<sup>6</sup>*

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- 3. Sullivan Nicolaides Pathology, Brisbane, QLD, Australia.*
- 4. Hunter Industrial Medicine, Newcastle, NSW, Australia.*
- 5. Summit Toxicology, LLP, Falls Church, VA, United States.*
- 6. Queensland Alliance for Environmental Health Sciences, University of Queensland, Brisbane, QLD, Australia.*

Abstract: In Australia, systematic biomonitoring of persistent organic pollutants (POPs) in pooled serum samples stratified by age and sex has occurred every two years between 2002/03 and 2012/13. Multiple regression modeling on log<sub>10</sub>-transformed serum pool concentrations of BDEs 47, 99, 100 and 153 and on the sum of these ( $\Sigma$ 4PBDE) was conducted to examine trends by sex and time since baseline, stratified by age group. Temporal trends were age- and congener- specific, with the largest changes per year of observation in the 0-4 year old group, with  $\beta$  (SE) = -0.098 (0.013) for log<sub>10</sub>BDE47; -0.119 (0.012) for log<sub>10</sub>BDE99; -0.084 (0.014) for log<sub>10</sub>BDE 100, and -0.053 (0.013) for log<sub>10</sub>BDE153, all  $p < 0.001$ . Adults over age 16 showed much smaller decreasing temporal trends for BDE47 and BDE99, no significant changes in BDE100, and, for the oldest age groups, slight increases in BDE153. As a result,  $\Sigma$ 4PBDE concentrations were stable over the entire time period in adults older than 16. Concentrations of each BDE in pools from females aged 31-60 were significantly lower compared to males. Relative proportions of BDE47 declined, while BDE153 accounted for a greater share of  $\Sigma$ 4PBDE over time. Whereas previously we saw a large elevation in the youngest age groups compared to older children and adults, this is no longer the case. This may be due to a decline in infant and toddler exposures in the indoor environment as use of PBDEs in consumer products has been phased out, suggesting temporal changes in the relative sources of exposure for young children in Australia.

### **O01.03.05. The Association of Urinary Phosphorous-Containing Flame Retardant Metabolites and Self-Reported Personal Care and Household Product Use among Couples Seeking Fertility Treatment**

Mary Ingle

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**Abstract:** Background Phosphorous-containing flame-retardants (PFRs) are widely detected. Increased exposure to PFRs has been associated with disrupting the endocrine and reproductive systems of animals and humans. While primarily used as a flame retardant, some PFR chemicals are also used as a plasticizer and have been detected in nail polish. Methods A subset of 230 women and 229 men from an existing longitudinal cohort were recruited from Massachusetts General Hospital fertility clinic between 2005 and 2015. At each visit, participants completed a 24-hour recall questionnaire of personal care product (PCP) and household product (HP) use. Metabolites [bis(1,3-dichloro-2-propyl) phosphate (BDCIPP), diphenyl phosphate (DPHP), isopropylphenyl phenyl phosphate (ip-PPP), tert-butylphenyl phenyl phosphate (tb-PPP) and bis(1-chloro-2-propyl) phosphate (BCIPP)] were measured in urine (1-5 samples; n=638 female, n=335 male). Associations among products and metabolites were assessed using multivariable generalized mixed models, adjusted for specific gravity, age, BMI, smoking, education, and season. Results: BDCIPP, DPHP, and ip-PPP were highly detected (66-89%). Concentrations were mostly higher among females and correlations among couples were weak ( $r \leq 0.31$ ). Moisturizer (60%), nail polish remover (77%) and nail polish (134%) were associated ( $p < 0.05$ ) with an increase in DPHP while concentrations of ip-PPP increased 21-27% with conditioner, cosmetics, deodorant and hair product use in females. In males, mouthwash and vinyl glove use were associated with an increase (31 and 92%) in DPHP. Conclusions: PFR metabolites were highly detected, although concentrations were higher among females. Weak correlations and inconsistent associations between females and males suggest that PFRs may also be used as a plasticizer in consumer products. Our findings suggest nail polish use may contribute to internal DPHP exposure. Further research of PFR compounds in PCP and HP is necessary.

### **001.03.06. Intervention to Reduce Gymnast Exposure to Flame Retardants: A Case Study**

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Abstract: We previously reported that gymnasts can have high, quasi-occupational, exposures to flame retardants (FRs) due to their use in gymnastics safety equipment such as the loose foam pit, which is used by gymnasts to learn new skills safely. Such exposures are likely widespread, as we previously identified FRs in the majority of foam samples collected from gyms across the U.S. and it is reported that 4-5 million kids and teens train at U.S. gymnastics clubs. Therefore, our objective in this case study was to quantify changes in gymnast exposure to FRs following an intervention that replaced the foam pit using FR-free foam. We collected samples from the foam pit as well as hand-wipe samples from 15 collegiate gymnasts before and after a gymnastics practice both pre- and post-intervention (n=42 hand-wipe samples total). Samples were analyzed for FRs using GC/ECNI-MS and GC/EI-MS. FRs identified in samples from the foam pit included tris(1,3-dichloro-2-propyl) phosphate (TDCIPP) and the Firemaster 550<sup>®</sup> mixture which includes 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB), bis(2-ethylhexyl)-2,3,4,5-tetrabromophthalate (TBPH), and triphenyl phosphate (TPHP). When concentrations of these FRs in hand-wipes were summed we observed a 1.4-fold increase in the GM concentration from before to after practice pre-intervention (p=0.01, n=10) whereas only a 0.4-fold increase was observed post-intervention (p=0.16, n=10). These differences were more pronounced among those who reported using the foam pit, with a 3.5-fold increase pre-intervention (p=0.06, n=5) and a 1-fold increase post-intervention (p=0.03, n=7). The distribution of these differences declined from pre- to post-intervention (p=0.01). Overall, these findings indicate that replacing a foam pit using FR-free foam can substantially reduce gymnast exposure to FRs used in foam.

## 001.03B. A Global Look at Lead Exposures

### **001.03.07. Environmental Justice Analyses May Hide Inequalities in Indigenous People's Exposure to Lead in Mt Isa, Australia**

Nathan Cooper

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Abstract: Elevated blood lead levels (BLLs) in children have been recorded in the city of Mt Isa due to lead emissions from the nearby mining and smelting facilities. Several studies have found that Indigenous children have had significantly higher geometric mean BLLs than non-Indigenous children, but there is a lack of recent BLL data to determine if Indigenous children in Mt Isa are disproportionately exposed to lead pollution. Environmental Justice studies have demonstrated cases of disproportionate exposure to pollution between communities by calculating the statistical relationships between the spatial distribution of ethnic communities and the concentration of pollution. Other epidemiological studies have found a significant association between children's BLLs and the concentration of lead in soil where they live. Taken together these findings suggest that there may be a significant correlation between soil lead concentration and the distribution of Indigenous children and their families in Mt Isa. To test for this correlation, we collected and analysed soil samples from 49 of the 51 census Statistical Area 1s (SA1s) in Mt Isa and measured the correlation between the soil lead concentration and the percentage of residents living in each SA1 who were of Indigenous status. Using linear regression and Kendall's tau, we found no significant correlations between any measure of Indigenous status with soil lead concentration, and little evidence of a relationship between socio-economic status (SES) and soil lead concentration. The results of our study indicate that Indigenous and low-SES residents are not disproportionately likely to live in areas with elevated concentrations of lead in soil, indicating that other factors are responsible for elevated BLLs. More research and policy attention should be given to risk factors that may be exacerbating the risk of exposure to lead in air or soil for low-SES children, including Indigenous children.

### **001.03.08. Blood Lead Levels in Children Aged 0 to 6 Years in China: A National Survey**

Chong-Huai Yan

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**Abstract:** Background : Lead exposure is a major environment-related disease that severely endangers child health. However, the magnitude of lead exposure among children in China remains unclear at the national level. We conducted a national survey of blood lead levels in children aged 0 - 6 years. Methods :From May 2013 to March 2015, we used a multi-stage clustered random sampling approach to select 90 districts/counties in 15 provinces across the country. Parents were interviewed, and the blood lead levels in children were tested using graphite furnace atomic absorption spectrometry. Findings: A total of 31,373 children with valid samples were included. The median and geometric mean blood lead levels were 26.4 and 26.7µg/L, respectively. The geometric mean blood lead level of children in Shanghai was the lowest (18.8µg/L), and that in Guangdong was the highest (33.7µg/L). The blood lead level of the children in the central region was the lowest (25.5µg/L) compared with the eastern region (26.6µg/L) and the western region (27.3µg/L). The geometric mean blood lead level of the children in large cities (24.2µg /L) was lower than that of the children in smaller cities (27.4µg /L) and rural areas (27.5µg/L). Boys had a higher lead level than girls (27.2 vs. 25.9µg/L,  $p<0.0001$ ). Children aged 36-84 months had a slightly higher lead level than children aged 0-36 months (25.7 vs. 27.9µg/L,  $p<0.0001$ ). Interpretation: The blood lead levels in children aged 0-6 years in China showed a dramatic decline compared with the past few decades. The blood lead levels of children were the lowest in the central region and among urban children in big cities. The blood lead levels of boys were higher than those of girls, and the lead levels were much higher in 36- to 84-month-old children than in 0- to 36-month-olds.

### **001.03.09. Three Decades of Lead Poisoning Prevalence in Mexico City Children: 1988 to 2015**

Ivan Pantic

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Abstract: Epidemiologic studies may be the best approach to estimate lead exposure of the general population in countries where there is no national surveillance of blood lead levels (BLL). The United States Centers for Disease Control and Prevention (CDC) established in 2012 a reference level of 5 µg/dL to identify children with elevated BLL which represents the 97.5 percentile of children ages 1-5 years. We used data from five birth cohorts from the same health services in Mexico City, including the Early Life Exposure in Mexico and Environmental Toxicants (ELEMENT, 4 distinct studies), that enrolled children and mothers and followed them longitudinally. We estimated the time trends in the prevalence of Mexico City children with BLL ≥ 5 µg/dL. We focused on BLL of children 1 to 5 years old between 1988 and 2015. A total of 2,562 children contributed with 7,557 samples, with a maximum of one sample per child per year. The median blood lead levels decreased from 14.5 µg/dL in 1988 to 1.6 µg/dL in 2015. In 1988 the prevalence of children with BLL ≥ 5 µg/dL was 100%. In 1997, when lead was completely eliminated from the gasoline in Mexico City, it was 86.3% and ten years later, in 2007, 32.8%. In the period from 2010 to 2015 the prevalence fluctuated between 10.8% and 4.2%, suggesting that the decline has plateaued. 30 years after eliminating leaded gasoline, remarkable progress has been made in reducing childhood lead poisoning, but there is still a high prevalence of children in Mexico City with elevated blood lead levels. Further public health interventions as well as a surveillance program are needed in order to further reduce lead, provide national estimates of blood lead levels in Mexico and to identify sources of exposure.

### **O01.03.10. Bone Lead Associations with Blood Lead, Kidney Function, and Blood Pressure among U.S. Lead-Exposed Workers in a Surveillance Program**

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**Abstract:** Background: Measurements of lead in bone represent cumulative exposure which, in many studies, has been more strongly associated with lead effects than blood lead (BL), which represents recent exposure. Aim: Determine whether maximum BL in the past is correlated with current bone lead and compare associations of bone lead with kidney function and blood pressure (BP) among workers. Methods: Adult men in a lead surveillance program living within 200 miles of New York City were enrolled during 2016-2017. Participants had tibia lead measured via K-shell X-ray fluorescence, BP taken, and blood drawn to measure BL and estimated glomerular filtration rate (eGFR). Maximum past BL was obtained from occupational surveillance programs (mean year first BL 1997). eGFR was calculated using serum creatinine and cystatin C. Multivariable linear and logistic regression models were used to determine associations with bone lead. Systolic and diastolic BP models excluded participants taking BP medicine. Results: Among 211 participants, median (interquartile range) bone lead, current BL, and maximum past BL were 13.8 (9.4-19.5) mg of lead per gram of bone mineral, 2.5 (1.5-4.4) mg/dl, and 29.0 (14.0-38.0) mg/dl, respectively. Maximum past BL, but not current blood lead, significantly predicted current bone lead in adjusted analyses ( $p < 0.0001$ , model R-square=0.27). In adjusted models, bone lead was moderately associated with low eGFR (bone lead odds ratio and 95% CI per 10 mg of bone lead for  $eGFR < 60 = 1.34 [0.97-1.87]$ ; the regression coefficient and p-value for continuous eGFR was also significant [ $p = 0.05$ ], model R-square=0.29). Bone lead in adjusted analyses was associated with increased systolic BP (regression coefficient=0.36,  $p = 0.02$ , model R-square=0.16). There were no associations between current blood lead and eGFR or BP. Conclusion: Bone lead was significantly correlated with past maximum BL and was associated with modest decreases in eGFR and increases in systolic BP.

### **O01.03.11. Point-Of-Care Analysis of Manganese and Lead in Water**

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**Abstract:** Metals are ubiquitous in the environment and have long been recognized to pose significant threat to human health. Blood lead (Pb) has been consistently associated with deficits in IQ and academic achievement; manganese (Mn) has been associated with Parkinson's disease or neurological malfunction in children. Current approaches for determining exposure (e.g., ICP-MS or AAS) require extensive labor, equipment, and long turnaround times. A relatively swift assessment of heavy metal exposure that ultimately reduces costs and turnaround times would benefit pediatric public health nationally and internationally. Our long-term goal is to develop a portable system with disposable sensors to move analysis from the laboratory to the clinical setting. Our sensor is based on electrochemical determination of Mn and Pb, and contains platinum working and auxiliary electrodes, and an electroplated Ag/AgCl reference electrode. An advantage of this sensor is the small size (~10mm on side), the need for only a few drops (~10 $\mu$ L) of sample, and rapid analysis (~10min). We are using cathodic stripping voltammetry for Mn, and anodic stripping voltammetry for Pb. The sensor operational parameters, such as deposition time and potential, supporting electrolyte and pH, were optimized for each metal. The sensor achieved detection limits of 0.9ppb for Mn and 4.4ppb for Pb. We conducted a pilot study to determine Mn and Pb in well drinking water samples from different sites in Marietta, OH (which is home a ferromanganese processing plant). Analyses were performed by diluting samples 2 $\times$  with pH5.5, 1M acetate buffer, and adding three spikes for the standard addition method. In these samples (n=7), the mean accuracy was 89% with mean precision of 97%, as compared with ICP-MS "gold standard" measurement by a reference lab. Ultimately, the sensor system could act as a simple, fast and low-cost alternative for point-of-care applications in local clinics or resource-limited settings.

### **001.03.12. Lead Exposure Biosensors from Epigenome-Wide Blood DNA-Methylation in Adults**

Elena Colicino

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**Abstract:** Background: Lead is a ubiquitous toxicant with a numerous chronic health effects. Between 2002-2011 more than 11,000 U.S. adults suffered acute lead-poisoning (>5 µg/dL). Acute symptoms are often misinterpreted or unrecognized and for this reason blood lead levels are likely under tested. Patella bone lead-a reliable measure of chronic cumulative exposure- is a highly specialized measure, requires exposure to X-radiation, and is available only in a small number of centers. Objective: To develop novel and safe biosensors reflecting individual current (blood) and cumulative (patella) lead exposure using whole blood DNA methylation profiles. Methods: We developed and tested two biosensors using data from epigenome-wide whole blood DNA methylation levels in men of the Normative Aging Study (NAS) cohort via the Illumina 450K bead chip. We selected methylation sites most responsive to lead exposure via robust regressions-adjusted for socio-demographic, life-style information and white cell proportions-and constructed the final biosensors using elastic nets. We used 10-fold cross-validation to test the biosensors. Results: Most NAS participants were exposed to relatively low levels of lead (median blood lead (Interquartile-range IQR) = 3 (3) µg/dL, median patella bone lead (IQR) 25.2 (20.2) µg/g). The elastic nets selected 1177 and 599 sites within the epigenome with non-null coefficients to estimate the blood biosensor and bone biosensor, respectively. Among the selected sites of both biosensors, only eight sites overlapped. The biosensors estimated lead levels that were highly correlated with actual values of blood (R<sup>2</sup>=0.92) and bone lead (R<sup>2</sup>= 0.96). Discrepancies were found mostly at extreme lead levels (in blood>7.5µg/dL, in bone>50µg/g). Conclusions: Our epigenetic lead biosensors are novel tools of measuring individual lead levels and may help identify lead-poisoning and its health impacts when available.

## 001.03D. Effects of Heat Waves

### **001.03.19. Heat Wave Effects on Mortality and Years of Life Lost in a Dry Region of Iran (Kerman) during 2005-2016**

Narges Khanjani

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**Abstract:** Introduction: The present study was conducted to compare the added effect of heat waves on mortality and years of life lost in Kerman, Iran during the years 2005-2016. Methods: Daily mean temperature and a combination of intensity and duration were used in order to define heat waves (90, 95 and 98th percentile and  $\geq 2, 3,$  and 4 consecutive days). YLL, considering discount rate, was calculated according to Iran's life table. In order to investigate the effect of heat waves in different lags and its cumulative effect on mortality and YLL, Poisson and linear models within distributed lag nonlinear models were used respectively. A maximum lag of 14 days was considered. The best model was selected based on Akaike Information Criteria. The model was adjusted for air pollutants, public holidays, days of the week and humidity. Results: The average daily mortality and YLL were  $10.54 \pm 4.31$  deaths and  $175.58 \pm 91.39$  years respectively. They were mostly related to men and were higher in heat waves matching a definition of above the 98th temperature percentile and  $\geq 2$  days, than others. Except heat waves defined as 98th percentile and  $\geq 4$  days, the effect of heat waves on mortality and YLL were the highest at Lag 0. The cumulative relative risk of total mortality was significant except in heat waves above the 90th percentile. The cumulative effect of heat waves on the total YLL was significant only above the 98th percentile. Men over 65 years old were the most vulnerable group in term of both mortality and YLL. Conclusion: Heat waves with temperatures above the 98th percentile for all three durations had a significant effect on both YLL and mortality in Kerman, Iran.

### **O01.03.20. Heat-Related Mortality Trends and Human Adaptation Response to Climate Warming in Spain: A 30-Year Observational Study by Sex and Cause of Death**

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**Abstract:** Background. Anthropogenic greenhouse gas emissions have increased summer temperatures in Spain by nearly one degree Celsius over the last three decades. However, little is known about the extent to which the associations between heat and human mortality have been modified due to societal adaptation. We investigate whether warmer summers are associated with an upward trend in excess mortality attributable to heat or, on the contrary, this trends has been counterbalanced by an adaptive response of the population. Methods and findings. We analyzed a large dataset from 46 capital cities in Spain for the summer months between 1986 and 2015, which included daily temperatures and number of deaths from circulatory and respiratory causes by sex. We applied standard quasi-Poisson regression models, controlling for seasonality and long-term trends, and estimated the temporal variation in heat-related mortality with time-varying distributed lag nonlinear models. The results pointed to a strong and progressive reduction during the study period in relative risks of cause-specific and cause-sex mortality across the range of summer temperatures, which led to downward trends in overall heat-attributable deaths. Conclusions. The summer warming observed during the last decades in Spain has been completely counterbalanced by an adaptive response of the population, which has led to a sustained downward trend in heat-related human mortality. This reduction occurred in parallel with a decline in the gender vulnerability gap between men and women. Despite these advances, the risk of death remained high for respiratory diseases, and particularly in the case of women.

## **O01.03.21. Forty Years of Heat Waves in France: A Tale of Climate Change and Health**

Mathilde Pascal

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**Abstract:** Introduction: Heat waves are the most emblematic health risk directly influenced by climate change. This study documents changes in heat waves' characteristics between 1974 and 2013 in France, the associated mortality impacts, and the influence of the national heat prevention plan developed in 2004. Method: Daily temperature and mortality data were collected for the 96 metropolitan French departments. The French heat warning system definition was used to identify heat waves. Each heat wave was characterized by its duration, intensity (compared to warning thresholds), and associated excess mortality (compared to the previous years). We investigated if the association between mortality rates and intensity changed after 2004. Results: 921 heat waves were identified. The population exposed to dangerous heat waves has doubled between 1974-1983 and 2004-2013. There is no increasing trend in intensity. The mean intensity of the 2003 heat waves was 2-fold higher than any other event, underlying its exceptionality. We observed 31,661 [27,110: 36,188] excess deaths during the 921 heat waves, 45% before 2003, 48% in 2003, and 7% after 2003. The relative risk of mortality for a 1°C increase in intensity was 1.12 [1.11:1.14] before 2003, and 1.13 [1.10:1.17] after 2003. Discussion : Changes in frequency, geographic and temporal spread of heat waves are already observed in France, increasing the exposure of the population. Results do not support an influence of the heat prevention plan on the intensity-mortality relationship at the department scale. The year 2003 remains a unique year with no historical equivalent, and is an example of what may occur in the future. The health impacts of heat waves are the main observable health impacts of climate change. Developing easy-to-understand indicators to observe and describe their evolution is an asset to promote adaptation and mitigation policies.

### **O01.03.22. Quantifying the Mediating Effects of Ozone in the Relation between Heat Waves and Years of Life Lost**

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Abstract: Some studies have proposed that the role of ozone in studies of temperature and mortality is a causal intermediate that is affected by temperature and that can also affect mortality. However, no study has empirically investigated the mediating effects of ozone in the relationship between hot temperatures and health. We propose to use state-of-art causal mediation analysis to decompose the total effect between heat (using various heat waves definitions) and years of life lost (YLL) into: i) controlled direct effects (CDE) which represent the effect of temperature without ozone; and ii) natural indirect effects (NIE) that represent the specific mechanisms involving ozone formation during hot days and including primary pollutants emissions (i.e. NO<sub>2</sub>). We also conducted a 4-way decomposition to consider mediation and effect measure modification simultaneously. The study was conducted in Montreal for the 1990-2010 period. The total effect between heat waves and YLL was 362.54 (95%CI: 272.98; 452.09). We found a CDE of 312.87 (95%CI: 212.80; 412.94) and a NIE of 49.67 (95%CI: 4.44; 94.89). We did not find any evidence supporting an interaction between ozone and heat. The mediating effect of ozone in the impact of heat waves on YLL was relatively small (~14%). Studying such mechanisms in various locations is crucial as during heat waves, public health efforts are geared towards reducing exposure to heat but do not typically take into account exposure to ozone.

### **O01.03.23. Assessing the Impact of Cold and Heat Waves on Physical Activity in a Sub-Tropical Urban Population**

Janice Ho

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**Abstract:** Background: Extreme temperatures are increasing due to climate change, however research of their impacts on health behaviour are rare. While cold winter temperatures have been identified as a barrier to physical activity, an increase of extremely hot temperatures due to climate change may also potentially affect frequency of physical activity. This study aims to estimate the change of self-reported frequency of outdoor physical activity (PA) during cold and heat waves in a sub-tropical urban population and identify its predictors. Methods: A prospective population-based cohort telephone survey study was conducted in an Asian sub-tropical city, a week after a 2016 coldwave and followed-up 1.5 years after, a week after a 2017 heatwave. Measures on self-reported changes in outdoor PA in heat and cold waves, sociodemographic variables, health status, warning awareness, temperature-related attitudes and knowledge, and protective behaviours were collected. We conducted multivariable logistic regression analyses to assess predictors of change in outdoor PA over the two extreme temperature events. Results: Temperature and other meteorological variables were significantly different during the cold and heat waves from that prior. The response rate at follow-up was 42.8% (435/1017). Overall, more participants (53.3%) reported a decrease in PA in either or both the heat and cold waves, than reported an increase (10.3%), while 36.3% of participants maintained consistent PA in both the cold and heat waves. Decreased PA was associated with females, worsened health status in winter, awareness of temperature, and certain protective behaviours, while increased PA was associated with students, those under 45, higher income, and better health status in summer. Conclusions: Our findings suggest a greater decrease of outdoor PA during cold and heat waves, and identify gender, age, income, health status, temperature-related awareness, and protective behaviours to be associated.

### **001.03.24. Reduced Cognitive Function during a Heat Wave among Young Adults in Non-Air Conditioned Buildings**

Jose Guillermo Cedeno-Laurent

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**Abstract:** In many areas of the world, buildings are designed for harnessing heat during cold winters, and thus can exacerbate extreme temperature exposures during heat waves (HWs) by maintaining elevated indoor temperatures even when ambient temperatures have subdued. Previous research has documented the impacts of ambient temperature on cognitive function, but few have observed the effects of extreme heat on indoor temperatures during daily routines. The objective was to evaluate the differential impact of HWs on cognitive function among university residents of air conditioned (AC) and non-AC dormitory buildings. Forty-four subjects (central air AC, n=24; non-AC, n=20) were followed before, during, and after a HW. STROOP and Addition/Subtraction (ADD) tests were administered daily for a period of twelve days. The causal effect of the HW on cognitive function was evaluated using difference-in-differences modelling. Difference-in-Differences estimates show an increase in reaction time (STROOP=13.4%, p<0.001; ADD=13.3%, p<0.001) and reduction in throughput (STROOP=-9.9%, p<0.001; ADD=-6.3%, p=0.08) during HW among non-AC residents relative to AC at baseline. These deficits were found in a young, healthy population of students, showing that the impact of HWs extend beyond vulnerable populations. Our findings highlight the importance of incorporating sustainable adaptation measures in buildings to preserve cognition, economic productivity, and health in light of a changing climate and heatwaves that will be more frequent, severe, and longer-lasting in the future.

## 001.03E. Environmental Exposures and Birth Outcomes

### 001.03.25. Association between the Early-Life Exposome and Birth Weight

Remy Slama

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**Abstract:** Background: Several environmental contaminants have been identified as possibly influencing birth weight, mainly from single exposure studies. The Exposome paradigm offers perspectives to avoid selective reporting of findings and to control for confounding by co-exposures. Aim: To assess the association of the pregnancy exposome with birth weight. Methods: Within HELIX exposome project, 131 prenatal exposures, several of which had some a priori plausibility for an effect on fetal growth, were assessed using biomarkers and environmental models in 1,301 pregnant women from six European cohorts. Associations were assessed using deletion-substitution-addition (DSA) algorithm, which considers all exposures simultaneously, and exposome-wide association study (ExWAS), which considers them independently. We tested for pairwise interactions and corrected exposures for exposure misclassification through regression calibration. Results: Lead (median, 9.7 µg/l; interquartile range, IQR, 6.0 µg/l) was the only exposure associated with birth weight in the DSA model corrected for exposure misclassification (mean birth weight change for an IQR increase, -48 g, 95% confidence interval, -90; -6). No exposure passed the significance threshold of ExWAS corrected for multiple testing; the exposures most strongly associated with birth weight in ExWAS were lead (-48 g, 95% CI, -90; -6), fine particulate matter (PM<sub>2.5</sub>) absorbance in the third pregnancy trimester (-50 g; -94; -6) and PM<sub>2.5</sub> concentration in the third trimester (-33 g, 95% CI, -66, -1). There was no strong evidence of order-two interaction. Conclusions: Our study is one of the largest considering over 100 environmental exposures for effects on birth weight. Compared to single exposure studies, our Exposome approach allowed identifying exposures associated with birth weight while making all tests explicit, correcting for confounding by co-exposures, for exposure misclassification and considering interactions between exposures.

### **O01.03.26. Impact of Maternal and Paternal Preconception Urinary Bisphenol A (BPA) and Bisphenol S (BPS) Concentrations on Offspring Birth Size**

Carmen Messerlian

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Abstract: Infant size at birth is considered an important marker of the intrauterine environment. Accumulating epidemiologic evidence has shown associations of prenatal exposure to BPA to reduced infant birth weight. However, effects of BPA exposure before conception in either parent is unknown. Epidemiologic evidence on BPS - a BPA substitute - is practically absent. We examined associations between maternal and paternal preconception, as well as maternal prenatal urinary BPA and BPS concentrations and size at birth among 346 singletons born to couples from the Environment and Reproductive Health (EARTH) Study, an ongoing prospective preconception cohort of women and men seeking fertility evaluation in Boston, Massachusetts. Infant birth weight and head circumference were abstracted from delivery records. Mean preconception exposures were estimated by averaging urinary ln-BPA and ln-BPS concentrations in multiple maternal and paternal urine samples collected before pregnancy, and prenatal exposures estimated via multiple maternal pregnancy samples collected per trimester. Associations of urinary BPA and BPS concentrations with birth weight and head circumference were estimated using multivariable linear regression. Maternal preconception urinary BPA concentrations were inversely associated with birth weight and head circumference in adjusted models: each ln-unit increase was associated with a decrease in birth weight of 119 grams (95%CI: -212, -27), and in head circumference of 0.60 centimeters (95%CI: -1.2, -0.03). Additional adjustment for gestational age or prenatal BPA exposure modestly attenuated results. Women with higher prenatal BPA concentrations had infants with lower mean birth weight (-75 grams, 95%CI: -153, 2). Paternal preconception urinary BPA concentrations were not associated with outcomes. No consistent patterns emerged for BPS exposure. This study suggests that the maternal preconception period may be a sensitive window for BPA effects on birth outcomes.

### **001.03.27. Associations between Prenatal Toxicant Exposures and DNA Methylation at Birth and in Adolescence**

Jaclyn Goodrich

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**Abstract:** Epigenetic modification is one plausible mechanism linking early life environmental exposures to adverse health outcomes in childhood and adolescence. Evidence suggests bisphenol A (BPA) and phthalate exposures during sensitive periods modify the epigenome. We assessed whether in utero BPA and phthalate exposure are associated with DNA methylation levels throughout the genome at birth (n=89) and during early (n=79) and late adolescence (n=146) among children from the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) study. We also assessed age-related change in DNA methylation among a subset of children (n=96) with samples at birth that could be matched with DNA from one or two adolescent time points. The exposures of interest were concentrations of nine phthalate metabolites and BPA, which were quantified in third trimester maternal urine samples. The outcomes were leukocyte DNA methylation, assessed via the Infinium MethylationEPIC BeadChip, in cord blood and blood collected during early and late adolescence. Differential methylation analysis by exposure was conducted for 786,024 CpG sites using an empirical Bayes method adjusting for sex and estimated blood cell type composition. A false discovery rate approach was used to adjust for multiple comparisons (q-values). Primarily hypomethylated CpG sites (q<0.05) by prenatal exposure to BPA and five phthalates (metabolites of DEHP, DiBP, and BzBP) were identified in cord blood. For example, higher third trimester BPA was associated with hypermethylation of one and hypomethylation of 33 CpG sites. The association persisted into late adolescence for two of the hypomethylated loci. In the longitudinal analysis, methylation at thousands of CpG sites differed between matched samples from birth and adolescence. Further analyses are underway to investigate evidence for environmental deflection, whereby prenatal exposure to toxicants alters the trajectory of age-related changes in DNA methylation.

### **O01.03.28. Relationship between Polybrominated Diphenyl Ether (PBDE) Levels in Maternal Serum and Fetal Tissues during Mid-Gestation of Pregnancy and Associations with Placental Biomarkers of Growth and Development**

Julia Varshavsky

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Abstract: Polybrominated diphenyl ether (PBDE) compounds are flame retardant chemicals with adverse effects on brain development, which may be mediated by placental effects. Pharmacokinetic factors may lead to disproportionate exposure in the developing fetus, yet the maternal-fetal relationship is not well understood. We examined whether PBDE concentrations vary between mother and fetus during early-to-mid pregnancy and identified placental biomarkers of PBDE exposure that may influence placental growth and function using statistical methods that account for left censored PBDE data. We calculated correlations between levels of 19 PBDE congeners across three biological matrices (maternal serum, placenta tissue, and fetal liver) in 130 maternal-fetal units. We conducted an exploratory analysis in a subset of samples to identify biomarkers of PBDE exposures that may influence placental development and function. Detection frequency was highest for BDE-47 (> 93% across matrices). Congener BDE-28 was more highly detected in placental and fetal liver tissues than maternal serum (> 60% compared to < 20%). PBDE levels were similar or higher in maternal compared to placental and fetal tissues before and after lipid adjustment for most congeners. The median BDE-47 concentration in serum was 0.24 ng/g (95% CI: 0.22, 0.28), more than twice as high as the placental value of 0.10 ng/g (95% CI: 0.09, 0.12). The difference was more pronounced after lipid adjustment, with 35.5 ng/g lipid BDE-47 found in serum compared to 10.8 ng/g in the placenta. Lipid-adjusted BDE-28, -99, and -153 levels were ~ two times higher in the placenta and fetal liver. Biomarker changes were observed in a subset of 12 placental tissues. Prenatal PBDE exposures are correlated with maternal levels. Molecular biomarkers related to placental development and function may be informative measures of PBDE exposure in future studies.

### 001.03.29. Prenatal Exposure to Phthalates and Phenols and Infant Anogenital Distance

Tye Arbuckle

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Abstract: Measurement of endocrine sensitive endpoints, especially those that are sexually dimorphic, such as anogenital distance (AGD), can be used as sentinels for later adverse health effects arising from prenatal exposure to endocrine disrupting chemicals. Some studies have reported reduced AGD in male infants with increasing maternal urinary phthalate concentrations; one study reported an association in female infants, while others report no significant associations. Human studies of phenols and AGD are sparse. Phthalate and phenol concentrations were measured in 1st trimester urines in the pan-Canadian MIREC Study. After birth, short and long measures of AGD were conducted in 197 male and 195 female infants. Multiple linear regression models were created to examine the relationship between the AGD and the exposure of interest, including specific gravity and significant confounders as identified from the change-in estimate procedure. The same confounders were kept for all phenol and phthalate models. The anus-clitoris distance was negatively associated with the phthalate metabolite MBzP ( $\beta = -1.24$ ; 95% CI -1.91, -0.57) and positively associated with MEP ( $\beta = 0.65$ ; 95% CI 0.12, 1.18). The anopenile distance was positively associated with MnBP ( $\beta = 1.17$ ; 95% CI 0.02, 2.32) and the molar sum of low molecular weight phthalates ( $\Sigma$ LMW) ( $\beta = 1.10$ ; 95% CI 0.13, 2.08). No significant associations were observed between prenatal BPA or triclosan urinary concentrations and AGD in either sex. Given the large number of associations examined, the statistical associations observed may have been due to Type 1 error. The inconsistency in results between studies of prenatal phthalate exposure suggests that this issue is yet to be resolved.

### **O01.03.30. Interdisciplinary Research in Assessing Relationships between Environmental Mixtures and Birth Outcomes: What Are the Essential Components for Collaboration?**

Osnat Wine

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**Abstract:** Despite the potential utility of interdisciplinary approaches in addressing complex environmental health research questions, there is paucity of research. The Data mining & Neonatal outcomes (DoMiNO) project is an interdisciplinary research which explored relationships between environmental mixtures and adverse birth outcomes using innovative data mining methods. The project applied a collaborative approach building on participation, expertise and perspectives of researchers, clinicians, and knowledge-users to gain new knowledge and facilitate knowledge translation. To better understand collaborative, interdisciplinary research, we used qualitative case study methodology to identify essential components that may support the interdisciplinary environmental research from the team's experience. Using the DoMiNO project as an exemplar case study of collaborative research, data were obtained from a focus group with ten DoMiNO team members. Applying thematic analysis we identified essential structures, mechanisms, and attributes that supported the interdisciplinary team including: keeping open channels for feedback and ongoing rapport; providing different opportunities for engagement, participation and learning; ensuring repetition of backgrounds, methods and processes in an inclusive and supportive environment. These components, built relationships, enabled learning and created bridges between team members and disciplines. Specific motivators for collaboration were identified: individual roles; sharing results; the need to be flexible, patient, open minded/'let go' of usual ways of thinking and leadership commitment to the team building process. Interdisciplinary research is a long and complex journey and could be challenged by its nature and context. The components described support the collaborative research process, resulting in a worthwhile experience which provided exciting results and knowledge translation and exchange activities with researchers and knowledge users.

## 001.03F. Natural Environment and Health

### **001.03.31. Shedding Some Light in the Dark - Validity of Using Satellite Measurements to Estimate Light at Night Exposure**

Anke Huss

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**Abstract:** Background: Exposure to light at night (LAN) can perturb the biological clock and affect sleep and health. Several epidemiological studies have evaluated LAN levels measured by satellites, but the validity of this measure as a proxy for personal LAN exposure is unclear. Also, outdoor light at night measured by satellites displays higher levels in urban environments, which means that this measure could potentially represent a proxy for other, likely urban, environmental exposures. Objectives: We evaluated correlations of satellite-assessed LAN with measured bedroom light levels, and explored correlations with other environmental exposures, in particular air pollution, green space and area-level socio-economic position. Methods: We compared satellite measurements with nighttime bedroom measurements in illuminance (Lux) in 251 children and additionally evaluated correlations to other urban exposures such as air pollution, area-level socio-economic position and surrounding green in 3021 children. Results: Satellite-measured LAN levels (nanoW/cm<sup>2</sup>/sr) were not correlated with bedroom-measured Lux (Spearman corr. coeff. -0.02). There was a weak correlation if parents reported influence of outdoor light on indoor light levels (rS=0.31). Satellite-measured LAN levels were correlated to air pollution (rS=0.76 with NO<sub>2</sub>, rS=0.71 with PM<sub>10</sub>) surrounding green (rS=-0.68 for green space within 1km of the home), and weakly to area-level socio-economic position (rS=0.24). Conclusions: Our study results indicate that outdoor satellite-assessed LAN levels are not a good proxy for nighttime personal exposure in bedrooms, but rather a proxy for other urban exposures. Studies planning to evaluate potential risks from LAN should therefore consider modifying factors such as curtains and indoor lighting and perform indoor or personal measurements to validate their exposure proxies. Other environmental exposures should be accounted for in epidemiological investigations.

## **001.03.32. How Green Is Green? Modeling Urban Greenness Exposure in Environmental Health Research**

Lorien Nesbitt

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**Abstract:** Exposure to greenness has several health benefits, yet analyses are limited by uncertainty about accuracy of greenness metrics, often derived from different remotely-sensed data sources and using different spatial methods. This research (1) assesses the strengths and weaknesses of multiple greenness data sources and metrics for application in environmental health research, and (2) develops and tests an alternative greenness exposure metric that can be applied worldwide. **Methods:** We analyzed 5 data sources: Landsat time series, Landsat 8, Sentinel-2, RapidEye, and the Green View Index (GVI), derived from Google Street View. These data sets span various time series, resolutions and costs, and represent aerial and perspective views. We compared the Normalized Difference Vegetation Index (NDVI) using different imagery types and the GVI for various buffer distances around postal codes and examined sensitivity to spatial metrics and data sources. Based on these analyses, we constructed a spatially-weighted greenness metric combining data from Sentinel-2 and the GVI that incorporates neighbourhood street-level and at-home greenness. **Results:** NDVI showed correlations of between 0.65 and 0.85 among satellite types and demonstrated significant inter-variability. GVI showed low correlations with all other data types (0.25-0.40), suggesting an important new source of greenness data. Metrics were spatially sensitive, particularly at small distances and high resolutions, but lacked temporal sensitivity. Initial analyses suggest that the proposed metric is superior to traditional measures that overestimate neighbourhood greenness exposure and underestimate at-home exposure. **Conclusions:** This research is the first comparison of multiple remote sensing data sources and metrics, including both aerial and novel perspective views. It presents an alternative greenness exposure metric based on freely accessible data sources that may be applied in public health research internationally.

### **001.03.33. Associations of Surrounding Green, Air Pollution and Traffic Noise with General and Mental Health**

Jochem Klompmaker

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**Abstract:** Background: Several studies showed indications that mental health is affected by environmental exposures. Objectives: To evaluate the effects of combined exposure to surrounding green, air pollution and traffic noise with general health and aspects of mental health. Methods: We linked a Dutch national health survey of 387,195 adults with an external database on prescription of anxiolytics (N05B), hypnotics and sedatives (N05C) and antidepressants (N06A). Moreover, we added data on surrounding green based on the Normalized Difference Vegetation Index (NDVI) or a land-use database (TOP10NL), annual average air pollutant concentrations (including particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), and nitrogen dioxide (NO<sub>2</sub>) and road- and rail-traffic noise to the survey. We used logistic regression models to analyze associations of surrounding green, air pollution and noise exposure with self-reported general and mental health and medication prescription. Results: In single exposure models, exposure to air pollution was positively associated with all outcomes, while surrounding green was inversely associated with all outcomes. For example, for prescription of anxiolytics, we found an odds ratio [OR] of 0.83 (95% CI: 0.79, 0.88) per interquartile range [IQR] increase in green (TOP10NL) in a 1000m buffer and an OR of 1.14 (95% CI: 1.14, 1.19) per IQR increase in NO<sub>2</sub>. Road-traffic noise was only associated with prescription of anxiolytics (OR: 1.05 per 5 dB, 95% CI: 1.02, 1.07). Two-exposure analyses showed that the associations with surrounding green and air pollution generally remained, but they were attenuated. Conclusions: Surrounding green and air pollution were associated with general health and aspects of mental health.

### **O01.03.34. Green Space, Mental Health, Physical Activity and Body Mass Index in a Cohort of Women Up to 15 Years Postpartum: A Multilevel Longitudinal Study**

Xiaoqi Feng

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**Abstract:** Background: Most epidemiological studies of green space and health use cross-sectional data, focus on green space quantity and pay little attention to sensitive periods in the lifecourse. Objective: To examine trajectories in mental health, moderate to vigorous physical activity lasting at least 30 minutes (MVPA) and body mass index (BMI) in association with measures of green space quantity and quality among women in the postpartum period. Methods: 3574 women who did not change neighbourhood were observed up to 6 occasions each over 12 years from 2004 onwards (20,084 observations). Multilevel growth curve models were used to examine the patterning of the Kessler 6 psychological distress scale, MVPA, and BMI. Green space quantity was measured by percentage land-use. Green space quality was self-reported. Models were adjusted for Indigenous status, qualifications, employment, area disadvantage and remoteness. Results: Green space quantity was associated with lower BMI (e.g. 21-40% coefficient: -0.73kg/m<sup>2</sup> (95%CI -1.39 to -0.08). This association between green space quantity and BMI strengthened as women aged. BMI was not associated with green space quality. However, women who lived near good quality green space reported better mental health consistently over time (rate ratio 0.89, 95%CI 0.85 to 0.93) and also participated in MVPA more often (rate ratio 1.04, 95%CI 1.01 to 1.07). A two-way interaction suggested quality green space supports the maintenance of MVPA over time. Conclusions: Green space quantity and quality matter for different health outcomes in the postpartum period. Quality green space may help prevent a decline in MVPA as women age.

### **001.03.35. Urban Green Space and the Risk of Dementia: A Population-Based Cohort Study**

Lauren Paul

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**Abstract:** Background/Aim: A growing body of epidemiologic evidence has identified urban green space as a potential modifiable factor that can improve human health, especially mental health. However, little is known about whether urban green space exposure is associated with reduced risk of dementia. Methods: Our cohort consisted of ~1.7M adults aged 55 to 85 who were long-term Ontario residents prior to cohort inception in 2001. We restricted to individuals who resided in urban areas, and the cohort was followed until 2013. To quantify green space exposure, we used the Landsat 30m satellite-derived normalized difference vegetation index (NDVI) to represent the amount of green vegetation within 250m of individuals' homes using annual postal code addresses. Dementia incidence was ascertained using population-based health administrative data with a validated algorithm. Mixed effects Cox proportional hazards models were used to estimate the association between green space and dementia. The models included a variety of individual-level and area-level covariates (e.g., age, sex, SES, comorbidities, and air pollution). We also applied a number of sensitivity and stratified analyses to assess the robustness of our estimates. Results: Over the study period, 219,013 individuals in the cohort were diagnosed with dementia. The fully adjusted hazard ratio per IQR increase in green space was 0.96 (95% CI: 0.95-0.97). We did not observe any heterogeneity in our estimate after stratification by selected characteristics (estimates remained between 0.95-0.97). This estimate also remained consistent in sensitivity analyses of different NDVI buffer distances, SES adjustments, and model structures. Conclusions: Our study suggests that increased exposure to urban green space is associated with a reduced risk of dementia among older adults. To our knowledge, this is the first study to assess the relationship between urban green space and dementia.

### **O01.03.36. Active Commuting through Natural Environments and Mental Health: Results from the Phenotype Project**

Wilma Zijlema

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**Abstract:** Background Urgent public health problems associated with the urban built environment include physical inactivity and mental health problems. Natural commuting routes that invite people to commute actively could be beneficial for an active lifestyle and mental health. This study focuses on the association between active commuting through natural environments and mental health. **Methods** This cross-sectional study was based on adult participants of the Positive Health Effects of the Natural Outdoor Environment in Typical Populations in Different Regions in Europe (PHENOTYPE) project. Data were collected in four European cities from Spain, the Netherlands, Lithuania and the United Kingdom. Data on commuting behavior and mental health (Medical Outcome Study Short Form (SF-36) mental health subscale) were collected with questionnaires. Adjusted associations were tested using multilevel analysis. **Results** Of n=3584 respondents, 27.3 percent walked or cycled to work or school in a normal week in the past months, and 42.9% commuted through natural environments on a daily basis. No association between active commuting and mental health was found. Adjusted analyses showed that respondents commuting through natural environments on a daily basis had on average a 2.75 (95% CI 1.67, 3.83) point higher score on the mental health scale than those not commuting through those spaces every day. In stratified analyses, this association was stronger among active commuters ( $\beta= 4.03$ , 95% CI 2.13, 5.94) compared to non-active commuters ( $\beta=2.23$ ; 95% CI 0.92, 3.53), but this interaction effect was not statistically significant ( $p=0.472$ ). **Conclusions** Commuting (active or non-active) through natural environments was related to better mental health, despite that active commuting was not related to mental health, and the amount of nature was not related to active commuting. Cities should invest in spatial planning policies targeted at natural commuting routes.

## O01.03G. Occupational Exposure and Worker Health

### **O01.03.37. Innovations in Applied Decision Theory for Occupational and Environmental Health and Safety**

David Richardson

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Abstract: Miners are exposed to a complex mix of airborne hazards that can lead to chronic respiratory and cardiovascular diseases. Decisions about potential interventions to improve health and safety for miners require reasonable estimates of a potential intervention's impact. There are well-established methods for the analysis of epidemiologic data to estimate parameters that may be well-suited to etiological research and communication among academics, such as covariate-adjusted hazard ratios. In contrast, the epidemiological methods suited to decision-makers who evaluate policy choices is less well established. We have been developing innovative methods for decision making to improve mine health and safety, incorporating theoretical developments in decision theory and systems engineering. These users are likely to benefit from the proposed data visualization techniques that don't require epidemiological training to interpret. We illustrate some of these quantities and approaches in an applied context, and discuss how these can strengthen both epidemiology and decision making in occupational and environmental settings where people encounter a range of hazards. Results are illustrated using data for a recently-updated cohort of 28,546 Ontario uranium miners followed to ascertain vital status and cause of death through December 31, 2007. With 8572 deaths observed we rank-order cause-specific excess deaths, and years of life lost in a contemporary framework for competing events.

### **001.03.38. Heat Exposure and Injury Risk in Washington State Outdoor Construction Workers: A Case-Crossover Study Using High Resolution Meteorological Data and Workers' Compensation Injury Claims**

Miriam Calkins

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**Abstract:** Objectives: The primary objective of this study was to assess the relationship between heat exposure and occupational injuries in construction workers. Methods: The relationship between maximum daily humidex, a measure of apparent temperature, and Washington State Fund workers' compensation injuries in outdoor construction workers was assessed using a case-crossover design with time-stratified referent selection. Warm month (March-October) adult outdoor construction traumatic injury claims from 2000-2012 were spatiotemporally joined with high-resolution meteorological data. Conditional logistic regression with linear splines was used to assess the association between maximum daily humidex and injuries. Results: There were 63,720 traumatic injuries during the study period. The traumatic injury odds ratio (OR) was 1.0053 (95% CI 1.003, 1.007) per one °C change in humidex. In the splines analyses, we observed a nearly linear association between humidex and the risk of a traumatic injury. Stratified analyses suggested higher risk in younger (18-24 years) and older (over 54 years) workers, workers with lower extremity injuries, workers with less job experience, smaller employers, workers working in Western Washington, and time of injury before 12:30 pm. Conclusions: In this study of Washington outdoor construction workers, increasing maximum daily humidex was associated with increasing traumatic injury risk. Further work should explore mechanisms of the association between heat exposure and traumatic injuries. Injury prevention efforts in construction should address heat-related risk factors, particularly for high-risk workers. In addition, heat awareness campaigns should address outcomes beyond heat-related illness.

### **O01.03.39. Circadian Variation of Melatonin and Steroid Hormones and Metabolites in Male Shift Workers**

Manolis Kogevinas

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**Abstract:** Background: Night shift work has been associated with increased risk for breast and prostate cancer. The effect of circadian disruption on steroid hormone production and metabolism is a possible underlying mechanism that is under-investigated in humans. We assessed circadian rhythms of steroid hormones and melatonin in rotating male shift workers in within subjects comparisons minimising potential effects of confounding. Methods: We recruited 50 shift workers rotating in a 3week night, 3wk evening and 3wk morning schedule. Participants collected urine samples from all voids over 24 hours sampled on two working days (3wk night; 3wk morning shift). Urinary concentrations of 51 steroid hormones and metabolites (estrogens, progestagens, androgens, corticosteroids including cortisol) and 6-sulfatoxymelatonin (aMT6s), the main melatonin metabolite, were measured in all samples (creatinine corrected). Mean levels and peak time of hormones and metabolites were compared between night and day shifts using cosinor models. Results: Peak time of aMT6s production occurred 9 hours later in night compared with day shifts. Mean aMT6s levels were similar in night compared to day shifts indicating an adaptation of the rhythm to the shift schedule. Night shift work was associated with a phase delaying (later peak) effect for steroid hormones, which was strongest for cortisol, several androgens and progestagens. Workers in night shift had lower average levels of cortisol, cortisone and androgens but not for their metabolites, nor for progestagens and estrogens. Conclusions: Workers during night shift had a delay in peak time of aMT6s production compared to day shift. We found also mistimed production for several steroid hormones. The pattern observed indicates complex endocrine pathways to disease that involves a wide range of hormones and is not limited to changes in melatonin production and metabolism.

### **001.03.40. Occupational Noise, Job Strain and Salivary Cortisol: A Repeated-Measure Study**

Ta-Yuan Chang

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**Abstract:** Background: Exposure to occupational noise and job strain have been reported to be associated with the salivary cortisol levels, but the combined effect is not clear. This study aimed to investigate individual and interactive associations between occupational noise exposure and job strain on salivary cortisol levels. Methods: We recruited 120 volunteers in an aircraft manufacturing company in Central Taiwan as study subjects. Each participant was performed 24-hour measurements of noise exposure and collected four salivary samples during different periods on the working day. The enzyme-link immunosorbent assay was applied to determine salivary cortisol levels. We also used questionnaire to obtain information related to job strain, sleep quality and other confounders. Multiple linear regression models were performed to analyze the association. Results: Workers exposed to  $\geq 75$  A-weighted decibels (dBA) had a significantly higher difference of salivary cortisol levels between 30-min waking-up and last-night sleep compared with that in workers exposed to  $< 75$  dBA and office workers, respectively. Workers exposed to high job strain (Index  $\geq 61$ ) had a significantly higher mean of salivary cortisol levels after 30-min waking-up and a significant difference between 30-min waking-up and last-night sleep than those with the low job strain (Index  $< 61$ ). Subjects co-exposed to noise levels  $\geq 75$  dBA and high job strain had a significantly higher mean of salivary cortisol levels after 30-min waking-up ( $0.371 \pm 0.098$  mg/dL,  $P < 0.001$ ) and a significant difference between 30-min waking-up and last-night sleep ( $0.323 \pm 0.094$  mg/dL,  $P < 0.001$ ) compared with those exposed to  $< 75$  dBA and low job strain. Conclusions: Occupational noise exposure and high job strain was associated with the increased salivary cortisol levels after 30-min waking-up. Co-exposure to noise and job strain may have a synergistic interaction with the salivary cortisol levels.

### **001.03.41. Hearing Loss in Agricultural Workers Exposed to Pesticides and Noise**

Nattagorn Choochouy

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Abstract: Pesticides have been identified as potential ototoxic agents, however it has been difficult to assess whether there is a synergistic relationship between pesticide exposure and noise since they frequently occur simultaneously in agricultural settings. This study was designed to investigate the risk of hearing loss in agricultural workers exposed to pesticides and/or noise. We recruited 317 Thai agricultural workers in three groups; 163 chemical-use farmers exposed to both pesticides and noise from agricultural machines (G1), 76 organic farmers exposed to only noise from machines (G2), and 78 organic farmers exposed to neither noise nor pesticides (G3). Questionnaires for pesticide use based in the NCI cumulative pesticide exposure algorithm (Dosemeci, 2002) and information on farm machinery use patterns along with noise levels measured on agricultural machinery were used to estimate cumulative exposure levels for noise and individual pesticides used by each person. All subjects underwent pure tone audiometric testing for low (L-PTA) and high frequencies (H-PTA). An average hearing threshold >25 dB was classified as hearing loss. A multivariate logistic regression analysis revealed that the G1 group (exposure to pesticide and noise) and the G2 group (noise only) had a significantly increased the risk of H-PTA hearing loss, compared with the G3 group (no noise or pesticide exposure) even after controlling for age, gender, smoking and years working as a farmer. Both higher cumulative noise exposures and higher cumulative organophosphate insecticides exposures were significantly associated with the increased odds of hearing loss in H-PTA, however, the interaction between noise and pesticides exposures was not significant. This study supports the hypothesis that exposure to organophosphate insecticides and noise increase the risk of hearing loss, but that this relationship is not synergistic.

## **O01.03.42. Association between Occupational Exposures to Irritants and Biomarkers of Oxidative and Nitrosative Stress in the Egea Study**

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**Abstract:** Introduction the biological mechanisms by which occupational exposures to irritants affect asthma are poorly understood. Oxidative/nitrosative stress pathway is involved in asthma and has been suggested as a mechanism of interest for the effect of irritants. Aim To test this hypothesis, we studied the associations between occupational exposures to irritants and 8 biomarkers related to oxidative/nitrosative stress. Analyses were done in participants without asthma, in order to evaluate associations independently of asthma-driven oxidative/nitrosative stress. Methods We analyzed data from 740 adults without asthma from the EGEA2 study, a case-control and family-based study (2003-2007; mean age: 47 years, 45% men). A new asthma specific job exposure matrix (Le Moual OEM 2018) was used to evaluate exposure to irritants including subgroups (e.g highly reactive chemicals, biocides; non-mutually exclusive categories). Exposure at the current job was evaluated in 3 levels (no exposure/medium/high). Biomarkers of internal dose, response or damage were measured in blood (SOD, GPX, catalase, FIOPs, NO<sub>2</sub>/NO<sub>3</sub>, CC16) or in exhaled breath (FeNO, 8-isoprostanes). Linear mixed models adjusted for age, sex and smoking were used to study the associations between exposures and biomarkers (outcomes), taking into account familial dependency. Results Overall, 31% of participants were exposed to irritants. Among the 8 biomarkers, only FIOPs level, a biomarker of damage related to oxidative stress, increased significantly across level of exposure to irritants (no/medium/high) (FIOPs GM[95%CI] 95[93-97], 98[95-102] and 99[94-104] RFU/mL, ptrend=0.04). Similar results were observed for highly reactive chemicals and biocides (all ptrend=0.002). All associations were stronger in men. Conclusion We observed a dose-response relationship between level of occupational exposures to irritants and FIOPs, supporting a role of damage due to oxidative stress in health effects of these exposures.

## 001.03H. Panel Studies of Air Pollution, Inflammation, COPD, and Lung Function

### **001.03.43. Association between Individual Indoor PM<sub>2.5</sub> Exposure and Peak Expiratory Flow Rate in Schoolchildren.**

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**Abstract:** Background: PM<sub>2.5</sub> exposure is known to have adverse effect on respiratory function in children. However, most of the previous studies were based on the ecological evaluation of outdoor exposure. The aim of the present study is to examine the association between individually monitored indoor PM<sub>2.5</sub> concentration and peak expiratory flow rate (PEFR). Methods: We recruited 30 9-year-old children to conduct a panel study. Each child's PM<sub>2.5</sub> exposure was measured using indoor air quality station equipped with light-scattering particle sensor. The indoor air quality stations were installed at the children's classrooms and each child's bedroom at their homes. We calculated daily mean concentration for each child according to the time spent at each place. PEFR was measured using peak expiratory flow meter at their class rooms (during week days) and homes (during weekend) between 8 and 9 AM for 6 consecutive days. We measured the children's heights and weights to calculate the body mass index (BMI), and a questionnaire was administered to obtain information on covariates. We constructed mixed linear model to examine the association adjusting for age (months), sex, BMI, environmental tobacco smoke exposure and monthly average household income. Result: A total of 115 observations were included in the present analysis. The daily average PM<sub>2.5</sub> concentrations were between 38.6±11.6 and 67.3±15.8 µg/m<sup>3</sup>. The daily average PEFRs were between 266.1±48.57 and 276.2±48.86 L/min. The regression coefficient of PEFR (L/min) for the increment of 10 µg/m<sup>3</sup> of daily mean concentration of PM<sub>2.5</sub> was -2.27 (SE: 0.14, P-value: 0.098). Conclusion: We observed marginally significant adverse association between individually monitored PM<sub>2.5</sub> concentration and PEFR in 9-year-old children.

#### **001.03.44. Time-Lag Pattern of Short-Term Exposure to Traffic-Related Air Pollution and Changes in Exhaled Nitric Oxide in Asthmatic Children**

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**Abstract:** Background/Aim: Short-term exposure to traffic-related air pollution (TRAP) has been associated with asthma exacerbation and increases in exhaled nitric oxide (FeNO), a biomarker of airway inflammation, with time lags ranging from several hours to a few days. Very few studies have examined TRAP-FeNO associations on less than 24-hour timescale. Moreover, most of the previous studies have used central-site exposure data. We aimed to investigate the lag structure of changes in FeNO in response to black carbon (BC), a marker for diesel exhaust particulate matter exposure, at hourly resolution measured by personal monitors from 35 asthmatic children in seaport-adjacent communities in New Jersey. Methods: Thirty five children with mild-to-moderate physician-diagnosed asthma wore micro-aethalometers (AE51, Aethlabs) for around 30 days (1071 observations in total). FeNO was measured daily in late afternoon using a NIOX MINO. Linear-mixed effect model was applied to quantify the BC-FeNO association after adjusting for day-of-week, temperature, age and gender. The lag was stratified as every two hours within 24-hour before the time of FeNO measurement. Results: Based on data from the first 9 subjects, FeNO level was positively associated with 24-hour average BC exposure (0.69% [95%CI: -1.62%, 3.05%] per one  $\mu\text{g}/\text{m}^3$  increase in BC) in the adjusted model. However, we observed inverse associations between BC and FeNO within 24 hour prior to FeNO measurement, and the association was strongest at lag 14-16 hours (-5.5% [95%CI: -9.38%, -1.44%] per one  $\mu\text{g}/\text{m}^3$  increase in BC) The strength of negative associations increased from lag 4-6 hours to lag 16-18 hours, and then decreased and becoming positive, over lags 18-20, 20-22 and 22-24 hours. Conclusions: Given the known high spatial and temporal variation in exposure to TRAP, the preliminary results support the need for further study of time-lag patterns between exposure to TRAP and acute asthma outcomes.

## **001.03.45. Outdoor Air Pollution, Fluorescent Oxidation Products and Persistent Asthma: The EGEA Study**

Anaïs Havet

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**Abstract:** The biological mechanisms involved in the associations between outdoor air pollution and asthma are poorly known. We studied the associations between long-term exposure to outdoor air pollution, plasma fluorescent oxidation products (FOPs), a global biomarker related to oxidative stress, and persistent asthma. The study was based on adults with current asthma followed in the Epidemiological Study on the Genetics and Environment of Asthma (EGEA), (EGEA2: 2003-2007, baseline; EGEA3: 2011-2013, follow-up). Air pollutant levels were estimated at the participants' residential address by ESCAPE (NO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>) and the French institute of environment (O<sub>3</sub>). Persistent asthma was defined by current asthma (asthma symptoms, attack or treatment in the past 12 months) at EGEA2 and EGEA3. We conducted mixed models with random effects on city and familial dependence adjusted for age, sex and smoking habits. Among the 201 adults with current asthma at EGEA2 (39 years old in average, 48% men), 160 had persistent asthma at EGEA3. An increase of one interquartile range (IQR) of O<sub>3</sub> was associated with higher FOPs level (adjusted  $\beta$ : 0.02, 95%CI: 0.004-0.04), and with persistent asthma, although this later association was not statistically significant (adjusted (a)Odds Ratio: 1.34, 95%CI: 0.85-2.13). FOPs were not associated with the other air pollutants. Persistent asthma increased significantly with FOPs level (aOR: 1.81, 95%CI: 1.06-3.09 per an increase of 1 IQR of FOPs level). For the first time in adults, FOPs were associated with O<sub>3</sub> and persistent asthma. Our results add evidence on the role of oxidative stress as a biological mechanism involved in the effect of O<sub>3</sub> on the respiratory health.

## **001.03.46. Association of PM2.5 of Outdoor Origin with Biomarkers of Oxidative Stress in COPD Patients**

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**Abstract:** Introduction: Studies have shown effects of ambient particulate matter  $\leq 2.5$  microns in diameter (PM<sub>2.5</sub>) on oxidative stress biomarkers; however, less is known of these effects indoors in patients with chronic obstructive pulmonary disease (COPD). In this study, we assessed the association between indoor PM<sub>2.5</sub> apportioned into indoor and outdoor origin and biomarkers of oxidative stress. Methods: We recruited 82 men with COPD who ran a micro-environmental sampler in their home for 1 week up to 4 times a year (n=225 samples). Teflon filter samples were analyzed gravimetrically for indoor PM<sub>2.5</sub>, and outdoor PM<sub>2.5</sub> was measured at a central site. Daily indoor PM<sub>2.5</sub> was calculated and apportioned into indoor (PMin) and outdoor origin (PMout) using the indoor-outdoor sulfur ratio as a surrogate for infiltration. Urine samples were obtained for analysis of 8-OHdG and malondialdehyde (MDA). We fit mixed effects models with a random intercept for each participant and adjusted for age, race, season, time of urine collection, BMI, creatinine, diabetes, heart disease, indoor nitrogen dioxide, ambient temperature, and relative humidity. Results: We observed suggestive effects of total PM<sub>2.5</sub> on 8-OHdG, with the strongest effect on the 1 day lag (3.6% increase per IQR, 95% CI: -0.69-8.2). For MDA, there were statistically significant effects of total PM<sub>2.5</sub> with longer moving averages (strongest effect on the 1-7 day moving average: 6.5% per IQR, 95% CI: 0.88-12.4). Effects of PMout across time windows displayed similar yet stronger patterns compared to total PM<sub>2.5</sub>, with the greatest effects on the 1 day lag (16.7% per IQR, 95% CI: 1.8-33.7) for 8-OHdG and the 1-7 day moving average (19.3% per IQR, 95% CI: -0.9-43.6) for MDA. There were no statistically significant effects of PMin. Conclusions: Our results suggest that indoor infiltration of PM<sub>2.5</sub> of outdoor origin is positively associated with increased lipid peroxidation (MDA) and DNA oxidation (8-OHdG) in patients with COPD.

## **O01.03.47. Comparison of Air Pollution and the Inflammatory Response of Local Residents in Urban and Rural Beijing, China -- Results of Airless Project**

Yiqun Han

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**Abstract:** Introduction Owing to rapid urbanization, residents in urban and rural greater Beijing area may be exposed to a diverse mixture and varying concentrations of ambient air pollution, resulting in different health responses. However, such comparative investigations are largely lacking.

**Methodology** This study is a part of AIRLESS project, a China-UK joint research which has integrated two intensive air pollution monitoring campaigns, and individual-based panel studies with 250 subjects (aged 40-70 years) recruited from two well established cohorts in urban and rural Beijing. This study aims to quantify and compare 1) ambient PM<sub>2.5</sub> concentrations in rural and urban Beijing, and 2) the acute effect of PM<sub>2.5</sub> exposure on respiratory and systemic inflammatory biomarkers in local residents. During winter 2016 and summer 2017, each subject completed 4 individual clinical measurements of exhaled NO (FeNO) and blood monocytes counts. These health outcome data were then linked with ambient PM<sub>2.5</sub> concentrations obtained from parallelly conducted local monitoring campaigns. Linear mixed-effect models were used to estimate any association. Results Preliminary results showed a clear spatial and seasonal variation of ambient PM<sub>2.5</sub> concentration, where daily mean(SD) of PM<sub>2.5</sub> during winter and summer were 85.5(78.7) and 48.7(19.2) µg/m<sup>3</sup> at the urban site, and 134.0(110.9) and 31.4(14.6) µg/m<sup>3</sup> at the rural site, respectively. An IQR increase in previous 1-day ambient PM<sub>2.5</sub> (58.0 µg/m<sup>3</sup>) was significantly associated with the elevation of FeNO [17.8%(95% confidence interval: 14.4-21.3%)] and monocyte counts [1.8%(1.5-2.1%)], after adjusting for covariates (P<0.05). Compared with urban subjects, rural residents showed a lower percentage change in FeNO (R vs. U = 13.1 vs. 30.1%) and higher in monocyte counts (R vs. U = 2.2 vs. 0.7%).

**Conclusions** Residents in urban and rural Beijing are exposed to different ambient PM<sub>2.5</sub> concentrations, and have different PM<sub>2.5</sub>-associated inflammatory responses.

### **001.03.48. Association between Air Pollution Exposure and Inflammation in Chronic Obstructive Pulmonary Disease Patients in Beijing, China**

Yuan Yao

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**Abstract:** Background/Aim: Chronic obstructive pulmonary disease (COPD), characterized by chronic inflammation, is one of the leading causes of death worldwide. The biological mechanism of inflammation associated with exposure to air pollution in COPD patients are not well understood. To elucidate the association between air pollution exposure and inflammatory response in COPD patients, 135 subjects, including 53 stable COPD patients and 82 healthy controls, were recruited in a panel study in Beijing, China. Methods: Fractional exhaled nitric oxide (FeNO) and serum cytokines were repeatedly measured from each subject during 4 visits. Levels of air pollutants, including mass and number concentration of fine particulate matter, mass concentration of black carbon/organic carbon (OC)/elemental carbon/ heavy metals, gaseous pollutants, were online monitored. Linear mixed-effect models were used to estimate the different inflammatory responses to the air pollution exposure between COPD patients and healthy controls. Results: Exposures to SO<sub>2</sub>, OC and ultrafine particles (UFP) were positively associated with the levels of FeNO, which were more significant in COPD patients. Increases in levels of IL-6 associated with CO, Mn and Cu exposures in COPD patients were significantly higher than those in healthy controls. Exposures to UFP and Acc were associated with increasing levels of IL-15, which were more significant in COPD patients. Exposure to CO was associated with decreasing levels of IL-1 $\beta$ , IL-4, IL-10, IL-13 and IL-17A in healthy controls, which was not observed in COPD patients. Conclusions: In summary, COPD patients are susceptible to the acute respiratory inflammation associated with air pollution exposure, and their capabilities to regulate inflammation are weaker than healthy controls. Acknowledgement: The study was funded by National Program on Key Basic Research Project (2015CB553401). We thank all the volunteers, students and staff involved in COPD for their contributions.

O01.03I. Social, Economic, and Demographic Disparities in Air Pollution Exposure and Health Outcomes

**O01.03.49. A National County-Level Assessment of U.S. Nursing Facility Characteristics Associated with Long-Term Exposure to Traffic Pollution in Older Adults**

Yi Wang

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**Abstract:** Background: Long-term exposure to ambient air pollution increases disease risk in older adults. Nursing facilities located near major roadways potentially expose older adults to traffic pollution. No studies, however, have described the association between nursing facilities and traffic pollution. Methods: We obtained data on facility- and census-tract-level characteristics of 15,706 U.S. facilities from the Medicare Nursing Home Compare datasets. We calculated distance to major roadways and traffic density for each facility. Results: In the contiguous U.S. (as of 2014), 345,792 older adults, about 27% of residents in non-hospital facilities, lived within 150 m major roadways (A1 or A2) in 3876 (28% of sampled) facilities. Nationally, for-profit facilities, high-occupancy facilities, and facilities in census tracts with higher percentages of minorities were more likely to have higher exposure to traffic. Counties in Virginia, New York City, and Rhode Island have the highest percent of residents and facilities near major roads. Conclusion: Nationally, over one-quarter of sampled facilities are located near major roadways. Attributes potentially associated with higher exposure to traffic included "for-profit" and "higher minority census tract". Proximity to major roadways may be an important factor to consider in siting nursing facilities. Our results inform potential intervention strategy at both county and facility level.

## **O01.03.50. Associations between Long-Term PM2.5 Exposure and Cardiovascular Outcomes Are Modified by Neighborhood Socioeconomic Effects in an Urban Area of North Carolina**

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Abstract: Exposure to PM2.5 air pollution, as well as neighborhood socioeconomic status (SES), are associated with cardiovascular disease (CVD) and diabetes. The joint effect of SES and PM2.5 on these outcomes can aid in understanding the effects of total environment on health. In this study, we examined whether neighborhood SES modified the effects of long-term PM2.5 exposure on the following outcomes: coronary artery disease index >23 (CAD) at the time of the index visit as determined by coronary catheterization, hypertension, and diabetes. We defined 6 neighborhood SES clusters based on a prior analysis of Ward's Hierarchical clustering of 11 Census variables. We analyzed data from 2192 cardiac catheterization patients residing in Wake, Durham, or Orange County, North Carolina. For each patient, we estimated annual mean PM2.5 concentration using a hybrid model with a 1x1 km resolution. All outcomes were assessed from medical records. We used logistic regression models adjusted for age, sex, race, body mass index, and smoking status, to assess cluster-specific and overall associations between PM2.5 and outcomes. We used interaction terms to define interactions by SES clusters. We observed significantly greater associations between PM2.5 and hypertension in clusters 1 (OR 1.22, 95% CI 0.99-1.50, pint 0.03) and 2 (OR 1.64, 95% CI 1.16-2.32, pint 0.003) compared to referent cluster 3 (OR 0.93, 95% CI 0.82-1.07). Clusters 1 and 2 were urban and had relatively high proportions of black populations, impoverished, non-managerial occupations, unemployed, and single-parent homes. In contrast, Cluster 3, the referent cluster, was urban with high proportions Bachelor's degree, and low proportions impoverished, non-managerial occupations and unemployed. In conclusion, neighborhoods of relative disadvantage have a stronger association between PM2.5 and hypertension compared with neighborhoods of relative SES advantage. This abstract does not necessarily reflect EPA policies.

### **O01.03.51. Disease Assimilation: The Loss of the Healthy Immigrant Advantage over Time with Exposure to Fine Particulate Matter**

Anders Erickson

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**Abstract:** Background. Immigrants make up 20 percent of the Canadian population, yet recent immigrants (< 20 years in Canada) are often excluded from air pollution mortality analyses to reduce possible confounding. Thus, little is known about the mortality impacts of fine particulate air pollution (PM<sub>2.5</sub>) on this population and how it changes over time. Methods. We used the 2001 Canadian Census Health and Environment Cohort (CanCHEC), a longitudinal cohort of 3.5 million subjects of which 764,000 were immigrants linked to annual mobility and PM<sub>2.5</sub> concentration from 1994 to 2011. Exposures were assigned as a 3 and 8-year mean prior to the follow-up year. Income tax files were used to account for residential mobility among respondents using postal codes, with probabilistic imputation used for missing postal codes in the tax data. We used Cox survival models to determine hazard ratios (HRs) for cause-specific mortality, and assessed year of immigration and country of origin. Results. In partially adjusted models (individual socioeconomic variables, airshed, and population centre size) stratified by age and sex, preliminary analyses of only immigrants compared the full cohort with immigrants as a covariate showed slightly lower HR estimates for cardiovascular (CVD) mortality: HR=1.07 (95% CI: 1.03 to 1.12) vs. HR=1.08 (95% CI: 1.06 to 1.10); and ischemic heart disease (IHD) mortality: (HR=1.09; 95% CI: 1.02 to 1.15) vs. (HR=1.11; 95% CI: 1.08 to 1.14) per 5 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> concentration respectively. The HR estimates of CVD, IHD and other chronic diseases increased with increased time in Canada among immigrants. Interaction models with country of origin and sensitivity analyses are on-going. Conclusions. Preliminary analyses suggest that air pollution is an equal opportunity risk factor; however, the relationship between immigration, health and air pollution is complex, partly due to unknown previous exposures along with a diverse and dynamic country of origin population.

## **001.03.52. PM2.5 and Mortality: Modification of the Association by Personal and Area Level Indicators of Socioeconomic Status**

Maayan Yitshak-Sade

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**Abstract:** Background Individual and contextual sociodemographic characteristics are important determinants of health. We investigated the modification of the relationship between PM2.5 (particulate matter <2.5 microns) exposure and all-cause natural mortality risk, by individual sociodemographic characteristics, neighborhood census sociodemographic indicators and measures of racial and economic segregation. Methods We obtained geocoded 2001-2011 mortality records from the Massachusetts Department of Public Health (n=527,208), and matched them to highly spatially and temporally resolved PM2.5 predictions from satellite-based models. We examined the association between PM2.5 and natural mortality using case-crossover analysis. We defined three groups of potential modifiers: (1) individual characteristics, (2) neighborhood sociodemographic characteristics from the US Census, and (3) neighborhood measures of racial and economic segregation and dissimilarity which incorporate the individual race and the uniformity of races and economic groups within the neighborhood. Results Each 10µg/m<sup>3</sup> increase in two-day average exposure to PM2.5 was associated with a 1.32% [0.94%; 1.69%] increase in mortality risk. The risk was higher among decedents without a college education and older persons (>85). The risk was modified by economic segregation and dissimilarity among younger aged decedents (<65) and effects were stronger in neighborhoods with higher percentiles of racial dissimilarity among ages ≥85 (5.93% increase, [3.03%;8.91%]). Census sociodemographic indicators did not modify the association in either of the age groups. Conclusion PM2.5 exposure is associated with increased daily deaths, and individual characteristics and sociodemographic indicators modify those risks. Neighborhood measures of segregation and dissimilarity, which incorporate individual and contextual sociodemographic characteristics, were found to be stronger modifiers than neighborhood census sociodemographic indicators.

### **001.03.53. Effect Modification of the PM2.5 Association with Birthweight by Local Residential Racial and Economic Segregation**

Kelvin Fong

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**Abstract:** Background: Maternal exposure to particulate matter under 2.5  $\mu\text{m}$  in aerodynamic diameter (PM<sub>2.5</sub>) during pregnancy is a well-established risk factor for decreased birthweight. Recently, there has been increased interest in how neighborhood racial and economic segregation modify health impacts of PM<sub>2.5</sub>. We therefore investigated the association between PM<sub>2.5</sub> and birthweight at different levels of racial and economic segregation. Methods: For each birth in Massachusetts from 2001 to 2013, we calculated the average PM<sub>2.5</sub> maternal exposure during pregnancy using the geocoded maternal residence at birth, infant birthdate, and clinical gestational age. Racial residential segregation (RRS) and economic residential segregation (ERS) indices were calculated at Census block group level and matched to maternal residence. RRS and ERS range from -1 to 1, with -1 indicating geographic concentration of the least privileged and 1 the most privileged. We quantified the association between PM<sub>2.5</sub> and continuous birthweight overall and in each quartile of RRS and ERS with regression analysis, controlling for individual risk factors. Results: In 783,966 singleton full-term live births, an interquartile range (IQR) increase in PM<sub>2.5</sub> (2.3  $\mu\text{g}/\text{m}^3$ ) was associated with a 20 g (95% CI: 18, 23) decrease in birthweight. RRS and ERS individually modified this association. The estimated birthweight decrease per IQR increase in PM<sub>2.5</sub> was 6 g (95% CI: 0, 12) in the lowest quartile of RRS (1Q); 22 g (95% CI: 17, 28) in 2Q; 17 g (95% CI: 12, 22) in 3Q; and 5 g (95% CI: 0, 9) in 4Q. For ascending quartiles of ERS, the estimated decreases per IQR increase in PM<sub>2.5</sub> were 12 g (95% CI: 7, 18), 24 g (95% CI: 19, 29), 14 g (95% CI: 9, 19), and 15 g (95% CI: 10, 20) respectively. Conclusions: Neighborhood racial and economic segregation modified the association between PM<sub>2.5</sub> and decreased birthweight. The impacts of PM<sub>2.5</sub> were most severe among those who lived in neighborhoods in the middle quartiles of RRS and ERS.

### **O01.03.54. Source-Specific Contributions to Fine Particulate Matter Exposure Disparities in the United States**

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Abstract: Efficiently addressing environmental injustice in air pollution exposure requires knowledge of the predominant sources of air pollution exposure disparities. Previous studies that have linked emissions sources to environmental injustice have used proximity to the emissions source as an exposure metric, but locations of emissions sources and the spatial patterns of the resulting concentrations are often only weakly correlated. We use the year-2014 US EPA National Emissions Inventory (NEI) and the Intervention Model for Air Pollution (InMAP) to estimate fine particulate matter (PM<sub>2.5</sub>) concentrations resulting from the more than 5,000 emissions source types included in the inventory, and we quantify associated exposure disparities by race-ethnicity. Preliminary results suggest 54% of source types, representing 62% of total PM<sub>2.5</sub> exposure, result in higher average exposures for minorities as compared to whites. Overall, minorities are exposed to average concentrations 1.7  $\mu\text{g m}^{-3}$  higher than whites. Significant source groups—those that contribute at least 1% of overall exposure—disproportionately impacting minorities include residential natural gas burning, commercial cooking, and highway vehicles (average exposure for minorities is 90%, 73%, and 39% higher, respectively, than whites). Significant source groups disproportionately impacting whites include coal power generation and agriculture (average exposure for whites is 26% and 15% higher, respectively, than minorities). These results can help policy-makers direct targeted efforts to mitigate inequitable exposure to air pollution.

## O01.03J. Transportation System and Health

### **O01.03.55. Biking Identification with the Micropem Accelerometer**

Jonathan Thornburg

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Abstract: Journals, time activity diaries, and other manual annotations of a participant's activities can be labor intensive, particularly if a wide variety of activities are required to meet study goals. To make better use of sensor data collected from the RTI MicroPEM, we developed a machine learning model to distinguish between "biking" and "non-biking" activity from MicroPEM accelerometer data. We started with a data set of 3424 observations for a single individual performing a set of activities (biking while standing, walking on treadmill, etc.) in a gym. These activities were timed and annotated by a researcher in an accompanying activity journal. MicroPEM accelerometer data sampled at 1 Hz to capture the 3-axis acceleration forces. Though more detailed activities were annotated for quality control, only two activity classes were assessed for the pilot, comprising of a 53/47 split between "biking" and "not-biking" observations. We used "N-fold" and "LOSO" cross validation methods to develop the activity identification algorithm. We obtained 94% accuracy with the Gradient Boosted Trees machine learning classification model. The accuracy increased to 99% after applying a sliding window that incorporated the statistical distribution of the data within +/- 3 minutes of the data under evaluation. Initial application of this algorithm to daily activities collected from study participants that commute via bicycle in New York City yielded a similar accuracy of 98%. Accuracy was assessed by correlating the time periods identified as biking with the GPS data recorded with the Strava application. The misclassification of 2% of the "biking" times most frequently occurred at the start and end of a biking session when the participant mounted or dismounted their bicycle. The ability to identify bicycling from the MicroPEM accelerometer data will provide a means to directly link the PM nephelometer data to this activity. Future work will apply machine learning to other activities.

### **001.03.56. Crashes when It Splashes: Link between Precipitation Type and Fatal Accidents in the United States**

Shubhayu Saha

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**Abstract:** Introduction: We conduct a comprehensive national assessment of the risk of fatal traffic crashes by examining the association of precipitation intensity with fatal accidents, specifically investigating how this association changes across seasons and time of day, controlling for known risk factors like alcohol and drug use. Methods: We combine two nationally representative datasets from 2006-2011 for the United States. First dataset contains the time and precise location of every reported fatal crash in the US from the National Highway Traffic Safety Administration (NHTSA). Second dataset contain estimates of actual precipitation conditions at the time of the fatal crash for the entire contiguous US using the high-quality national-scale NOAA NEXRAD reanalysis data at 1-km resolution with a 5-minute rate. The high temporal and spatial resolution of these datasets allow precise linkages of crashes with environmental conditions at the time of the crash. We estimate the fractional attributable risk of these crashes from the prevailing intensity of precipitation. Results: There were 184,169 reported fatalities in the NHTSA database for 2006-2011. Among those accidents involving alcohol and/or drugs, precipitation produces no discernible impact on the likelihood of a fatal accident. Meanwhile, about one quarter of the risk of fatal accidents without alcohol and/or drugs that take place during precipitation can be attributed to the precipitation itself. The attributable risk is least during light precipitation (FAR = 0.23) and greatest during moderate and heavy precipitation (FAR = 0.43 and 0.59, respectively). The risk is highest during the daylight hours. On an annual scale, light precipitation adds far more risk during the winter months than during summer, while heavier precipitation contributes a more seasonally independent risk. Conclusion: Our results show that precipitation at all intensities contributes a significant risk to fatal traffic accidents.

### **001.03.57. Using Spatially Resolved Pollution Data to Plan Bicycle Infrastructure**

Darby Jack

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Abstract: Highly resolved pollution data offers novel insights into where and when urban residents incur air pollution exposures. Armed with such data, urban planners can design infrastructure to minimize exposure. New York City, which has over 450,000 bike trips/day, offers a compelling place to examine the relationship between cycling infrastructure and exposure. Drawing on a novel high resolution dataset collected by volunteer bicycle commuters in New York City (n=43 with each participant riding as many as 12 times), we quantify how proximity to truck routes and type of bicycle infrastructure drive air pollution exposure during bike commutes. About 40% of the total cycling routes in NYC are along or within 50 meters of a designated truck route, and approximately 55% of the total distance traversed by study participants was within 50m of a truck route. We found that proximity to truck routes affects exposure, with decreasing concentrations with distance. For example, a simple dichotomy of data shows that while mean BC of < 50m of truck routes = 4.30 ug/m<sup>3</sup>, mean BC of > 50m of truck routes = 3.10 ug/m<sup>3</sup> (p = 0.015), with larger differences observed for different distance cut-offs. Bicycle lanes in New York City are categorized based on the degree of separation from vehicular traffic. Incorporating truck route and bike lane class data made available by the New York City Department of Transportation (DOT) with annual average daily traffic from the state DOT as a measure of traffic density, we model exposure to BC on a minute-by-minute basis as a function of bike lane class. Based on these results, we assess the potential health benefits that could be obtained by redesigning cycling infrastructure to minimize air pollution exposures.

### **O01.03.58. Spatial Variation of Injury Risk in a Metropolitan Area, According to Home Location, Transportation Mode, Distance Travelled and Route**

Felix Lamothe

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Abstract: At the route level, traffic volume and road geometry greatly influence the risk of injury. At the state or country level, population rates of road injuries vary according to household density and transportation mode. This study aims to integrate these two perspectives to describe the spatial variation of injury risk according to home location within a metropolitan area. Police reports (2006-2010) provided injury data (e.g. crash location). Population trips, travel mode and routes were estimated using a representative Origin-Destination Survey (2008) for the entire Montreal Metropolitan area. Home location for each individual was classified into population density quintiles, using property assessment rolls. Regression models were developed to estimate the number of car occupant, bus occupant and pedestrian injuries, accounting for exposure to traffic as well as road geometry. These models were applied to predict the risk associated with each road, intersection and highway and then accumulated throughout each trip. Results show that in the densest sector, injuries per kilometre of road are six times greater compared to the least dense one. At intersections, road segments and on highways, the number of injuries is strongly associated with traffic volume and proxies of vehicle speed. Unsurprisingly, trips by public transit are safer than by car. At the individual level, the likelihood of injury increases with distance traveled. People living in the least dense sector make more trips by car and travel greater distances and are almost three times more likely to be injured than those in the densest sector. Within a metropolitan area, more injuries occur in the densest sector, however it is the population living in the least dense sector that have the greatest risk of injury. In urban settings, road injury prevention strategies should not only target road geometry but also urban development.

### **O01.03.59. Impacts of Multi-Modal Commuting on Personal Air and Noise Exposures and Airway Inflammation**

Yisi Liu

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**Abstract:** Background: Modern mobility can include mixtures of transportation options, which potentially impact pollution exposures and health. Objectives: To investigate variations in traffic-related air and noise pollution exposures and cardiorespiratory effects in different microenvironments in Chengdu, China. Methods: Three sections of a city were chosen as locations for a scripted exposure study: The urban core, a developing neighborhood, and a suburb. Exposures for four commuting modes (car, bus, subway, and shared bike) with overlapping routes were measured using portable instruments (measuring PM<sub>2.5</sub>, Black Carbon, and noise) in summer and winter (5 repeats in each season). We assessed the feasibility of collecting health measures (ECG, breathing rate, respiratory minute ventilation, fractional exhaled nitric oxide, and spirometry measurements) in winter for four healthy, non-smoking young adults. Health measures on commute days were compared to a control measurement collected two days after the last commute. Results: Air pollutant measures showed large seasonal variance, with winter medians more than three times higher than those in summer (PM<sub>2.5</sub>: 33 vs 123 ug/m<sup>3</sup>, BC: 2395 vs 9125 ng/m<sup>3</sup>). The highest PM<sub>2.5</sub> and BC levels were measured in the urban core (both p<0.0001). Noise tended to be higher in the summer, and was higher in the suburb than other neighborhoods (p<0.0001). In summer, riding the subway had the highest pollution levels, while riding a car was found to be the least polluted mode (p<0.0001). In winter, the highest air pollution levels were found for shared bike use (p<0.0001); subway and bus trips had the lowest PM<sub>2.5</sub> and BC level respectively (p<0.0001). Preliminary linear mixed modeling suggested that riding a car may be associated with increased airway inflammation (p=0.004). Conclusion: Results from this study suggest that mode, location and season of transportation impact personal traffic-related pollution exposure and airway inflammation.

### **001.03.60. Associations between Children's Physical Activity and Exposures to Air Temperature and Green Space in Mexico City**

Sandy Wong

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**Abstract:** Background/Aim: Global increases in sedentary behavior are a major public health concern requiring research into its causes. We investigate environmental factors such as temperature and green space that may predict physical activity among children 4-6 years of age, since active children are more likely to exercise regularly over the course of their life. Methods: We use children's data collected in the years 2013-15 in a subset of the Mexico City PROGRESS cohort (n=383). Children wore accelerometers for a week recording their activity levels. For physical activity, we calculated mean, maximum, and minimum hourly vertical counts by day and by week. We estimated children's exposure to green space using 50m resolution seasonal maximum NDVI (Normalized Difference Vegetation Index), a satellite-based measure of greenness; and exposure to air temperature with a daily 1km resolution model developed by our group using data from satellite-based land surface temperature and weather stations (CV R<sup>2</sup>=0.89). For our analysis, we use multiple linear regression models adjusted for child and mother covariates, including child BMI z-scores. Results: We find maximum daily temperature to be positively associated with maximum hourly vertical counts. Children had on average 0.06 SD units higher exercise for each 1°C higher ambient temperature (p=0.002, temperature range 11-31°C). When stratified by gender, the significant and positive association holds for girls but not for boys. We do not find a significant relationship between green space and physical activity. Discussion: Our findings suggest that temperature, but not green space, is an important environmental influence associated with children's physical activity, particularly for early school age girls in Mexico City. Our findings may not generalize to other climates or non-urban areas that have more green space. We recommend that future epidemiological projects consider weather variations when analyzing physical activity data.

O01.03K. Stress, Inflammation, and Cardiopulmonary Outcomes in Scripted and Experimental Air Pollution Exposure Studies

**O01.03.61. Forced Expiratory Volume in 1 Second Is Not Affected by Exposure to Diesel Exhaust and Cycling Exercise in Individuals with Exercise-Induced Bronchoconstriction**

Sarah Koch

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**Abstract:** **PURPOSE:** To assess the effect of diesel exhaust (DE) exposure before and during cycling exercise in individuals with exercise-induced bronchoconstriction (EIB) on lung function following the inhalation of a bronchodilating agent (salbutamol, SAL). **METHODS:** Seventeen 22-34 year-olds (9 females) with an EIB diagnosis were included in this double-blind randomized crossover study. In four exposure visits, participants performed a 30-minute cycling bout while breathing either DE or filtered air (FA) after the inhalation of either 400 $\mu$ g of SAL or placebo (PLA). After the inhalation of SAL or PLA, participants sat in the exposure chamber for 60 minutes. Following this rest period, participants cycled for 30 minutes at 50% of peak work rate achieved on their screening visit. During both the rest and cycling bouts, participants breathed either DE (PM<sub>2.5</sub> = 300 $\mu$ g/m<sup>3</sup>) or FA. Forced expiratory volume in 1 second (FEV<sub>1</sub>) was assessed at baseline, after the 60-minute resting period, immediately upon completion of the cycle bout, and 60 minutes after the completion of the exercise bout (~3 hours after IBA treatment). Participants were asked to withhold asthma medication 12 hours prior to testing. **RESULTS:** The inhalation of SAL led to a significant increase in FEV<sub>1</sub> in the DE (baseline: 3.5 $\pm$ 0.9L; 60 minutes following rest: 3.8 $\pm$ 1.0L, p=0.04) and FA condition (baseline: 3.5 $\pm$ 0.9L; 60min: following rest: 3.8 $\pm$ 0.9L, p=0.02). Breathing DE at rest and during the cycle bout did not lead to changes in FEV<sub>1</sub> (p= 0.67). After the inhalation of PLA, FEV<sub>1</sub> averaged consistently at 3.5-3.6L ( $\pm$ 0.9L) in the DE and FA conditions across all four measurement points (p > 0.05). The cycle exercise did not affect FEV<sub>1</sub>, meaning that participants neither experienced exercise-induced bronchoconstriction nor bronchodilation. **CONCLUSIONS:** The exposure to DE prior to and during a 30-minute cycle bout does not affect FEV<sub>1</sub> in individuals with EIB following the inhalation of a bronchodilating agent.

## **O01.03.62. Particulate Metal Exposures Induce Plasma Metabolome Changes in a Commuter Panel Study**

Chandresh Ladva

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**Abstract:** Identifying air pollution (AP) components driving human health response remains costly and complex, with inconsistencies among results across studies. Sensitive, high-throughput methods may aid in discovery of AP-mediated health effects. Using measurements collected as part of a large, panel-based study of car commuters, we examined in-vehicle AP, targeted inflammatory biomarkers, and metabolomic profiles to trace metabolic perturbations associated with on-road, AP exposures through systems-level approaches. **Methods:** A 60-person panel of adults participated in a scripted crossover study, where each person conducted a highway commute and either a side-street commute or clinic exposure. Pre- and post-exposure dried blood spots were taken to examine 2h changes in targeted inflammatory biomarkers (interleukins and acute phase proteins) and plasma for 10h changes in the metabolome. High resolution metabolomics was compared with both exposures and changes in biomarkers. Features associated with either in-vehicle exposures or inflammatory biomarkers were subjected to pathway analysis using mummichog and MetaCore. **Results:** Particulate metal exposures and changes in inflammatory biomarkers were associated with measurable changes in the plasma metabolome. 150 total metabolite features associated with either aluminum, iron, or lead exposures. Of these, 9 overlapped with features associated with changes in one of IL-8, IL-1 $\beta$ , IL-6, or hs-CRP. Notably, metabolic pathway analysis of significant features indicated that these traffic-related pollutants were associated with leukotriene and arachidonic acid biosynthesis and tryptophan metabolism. **Conclusions:** In-vehicle metal exposures associated with within-day perturbations of several pathways; however, one pathway, leukotriene metabolism, was also associated to changes in inflammatory cytokines. Systems-level approaches generated actionable hypotheses with greater confidence through the use of multiple analytical platforms.

### **001.03.63. Exposure to Black Carbon and Acute Subclinical Health Effects: Results from a Panel Study in Three European Cities**

Evi Dons

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Abstract: Short-term exposure to high levels of traffic-related air pollution has been linked to numerous adverse health effects. Often exposure peaks are encountered in urban environments near traffic where individuals are also physically active. We aimed to assess the short-term effects of air pollution, physical activity, and their interaction on a set of subclinical cardiovascular and respiratory outcomes in healthy adults. A panel of 122 adults was recruited in 3 European cities: Antwerp, Barcelona, and London. Participants completed three measurement weeks in which they pursued their daily routines, and measured their personal exposure to black carbon (BC) (microAeth AE51) and physical activity level (SenseWear armband). After each week, health markers were measured: heart rate variability, retinal vessel diameters, lung function (FVC, FEV1, PEF), and fractional exhaled nitric oxide (FeNO). We used mixed effects regression models to assess responses to physical activity, BC, and their interaction. Separate models were used for 2-hour and 24-hour time windows before the health assessment. Physical activity and BC had opposite, independent effects on lung function in the 2-hour time window (physical activity on FEV1: +14.63mL,  $p < 0.1$ ; BC on PEF: -102.19mL,  $p < 0.05$ ). We observed an interaction effect between physical activity and BC on FEV1 and FVC ( $p < 0.05$ ), which suggests a protective effect of physical activity offsetting the BC effects on lung function. We also observed an increased sympathetic tone with both physical activity (log LF/HF: +0.08;  $p < 0.01$ ) and BC (log HF: -0.14 ms<sup>2</sup>;  $p < 0.1$ ). We did not observe consistent responses in FeNO or retinal vessel diameter in the 2-hour time window. No statistically significant changes were observed in the 24-hour time window. Independent effects from physical activity and BC exposure were observed; a combined effect was found for FEV1 and FVC indicating a protective effect of physical activity to BC exposure in the 2-hour time window.

### **O01.03.64. Modification of Ozone-Induced Changes in Lung Function by Moderate Recent Life Stress**

Radhika Dhingra

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Abstract: While changes in lung function (LF) due to ozone (OZ) exposure are well-documented in healthy populations, potential sources of response heterogeneity, like stress, remain uncharacterized. Though examined in diseased populations, the modifying effect of stress on air pollution induced LF changes has not been characterized in a healthy population. To assess the impact of stress on OZ-induced LF changes, we conducted a case-crossover study, where healthy subjects (N=40; 18-33y) were exposed in a controlled chamber to clean air (CA) and 300 ppb OZ for 2 hrs, with a  $\geq 2$ -week wash out between exposures. LF outcomes, FEV1, FVC, FEF25-75, were measured pre-exposure, post-exposure, and 18 hrs after exposure (follow-up). Recent stress levels were assessed using the Perceived Stress Scale-10 (PSS.10) survey, and dichotomized into low (PSS.10 < 10), and moderate/high (PSS.10  $\geq 10$ ; hereafter, high) stress. We used a linear mixed effects model with random participant intercepts to estimate and qualitatively compare these four contrasts: high vs. low stress, under CA and OZ exposures; OZ vs. CA, among the high and low stress groups. Findings are reported as difference in % change from pre-exposure baseline. High and low stress groups did not discernibly differ under CA exposure. In all participants, post-exposure FEV1, FVC and FEF25-75 were diminished with OZ exposure as compared to CA, but the decline in the high stress group (e.g. FEV1: -9.96, 95%CI(-6.66, -13.3)) was larger than in the low stress group (e.g. FEV1: -6.76 (-3.77, -9.75)). At follow-up, the effect of OZ on LF outcomes was indistinguishable from CA in the low stress group, but remained diminished in the high stress group. Our findings suggest that return to baseline of OZ-induced LF decline is attenuated in individuals experiencing moderate/high stress, and that stress may be responsible for a portion of heterogeneity in LF that is observed in response to OZ. This abstract does not necessarily represent EPA policy.

### **O01.03.65. Exposure to Air Pollution - A Novel Staircase-Function Response Mechanism of Stress Restoration**

Miaomiao Liu

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**Abstract:** Introduction: Given the epidemiological facts that exposure to air pollution induce the stress, reasonable hypothesis is made that it also hampers the stress restoration and further cause the mental health concerns. However, no studies examined the specific mechanisms so far. Methods: We adopted an environmental physio-psychological experiment paradigm of stress recovery to investigate the question. The experiment had three steps: (1) After entering the lab and sit in front of a computer monitor, participants were asked to relax for 1 minute. (2) Participants then took 10-minutes oral English tasks in the form of TOEFL test for evoking the stress. (3) Immediately after the stress evocation, 110 participants were randomly divided into seven groups. Then they were asked to relax for 3 minutes in the front of the monitor that displayed one group of blank pictures and six target groups of air pollution pictures with PM2.5 concentrations ranging from 11, 32, 51, 108, 165, to 231  $\mu\text{g}/\text{m}^3$ , respectively. During the experiment, Galvanic Skin Reaction (GSR) were selected as stress indicators and acquired using a BIOPAC MP 150 System and aggregated for obtaining the mean and maximum of GSR for each 10-seconds interval using Acqknowledge 4.0. Results and Discussion: According to the stress recovery patterns, six target groups were regrouped into three categories that matched the Air Quality Grading system in China well. For the first one with PM2.5 of 11-32  $\mu\text{g}/\text{m}^3$  (Grade: Good), participants presented the most obvious stress reductions of around 20% by the end of the third minutes. For the second one with PM2.5 of 51-108  $\mu\text{g}/\text{m}^3$  (Grade: Fine and Mild Pollution), moderate stress reductions of less than 10% were observed. For the third one (Grade: Moderate and Severe Pollution), participants' stress levels have not been reduced, but increased since the second minute. It revealed that there was a novel staircase-function response mechanism of stress restoration to air pollution exposure.

## **O01.03.66. A Crossover Study of In-Vehicle Air Filtration and Acute Changes in Heart Rate Variability and Cognition among Healthy Adults**

Robin Shutt

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**Abstract:** Background: Traffic-related air pollutants (TRAP) are known to negatively affect cardiovascular health, and personal exposures may be highest during rush hour commutes. We examined the effectiveness of cabin air filtration at reducing in-vehicle exposures to TRAP, and whether these exposures were associated with short term changes in heart rate variability (HRV) and cognition in healthy adults. Methods: A crossover study of cabin air filtration and in-cabin exposure to TRAP was conducted in Montreal, Canada in 2014. Forty-eight participants were exposed to TRAP during two separate commutes of approximately 90 minutes: one trip with an electrostatic cabin air filter and one trip without a cabin air filter. In-vehicle and outdoor rooftop measures of ultrafine particles (UFPs), fine particle matter (PM<sub>2.5</sub>), black carbon (BC), nitrogen dioxide (NO<sub>2</sub>), and volatile organic compounds (VOCs) were collected during the commute. HRV parameters were measured before, during, and after each exposure period. Linear mixed effects models were used to examine relationships between in-cabin air pollution concentrations and changes in time and frequency domain measures of HRV. Results: The cabin air filter reduced in-vehicle UFP concentrations by 28%, (mean difference= 26,232/cm<sup>3</sup>, 95% CI: 11,733-40,730), PM<sub>2.5</sub> by 30% (mean difference= 6 ug/m<sup>3</sup> 95% CI: 5-8), and BC by 32% (mean difference= 1,348 ng/m<sup>3</sup> 95% CI: -1,654-1,042 ng/m<sup>3</sup>). The air filter did not reduce in-vehicle concentrations of NO<sub>2</sub> or VOCs. In general, cabin air filtration was not consistently associated with changes in HRV. PM<sub>2.5</sub>, UFPs and BC were positively associated with changes in both time and frequency-domain measures of HRV during and after the commute; these associations tended to be stronger among women. Conclusions: Electrostatic cabin air filters can lower in-vehicle exposures to TRAP, particularly those pollutants produced in high concentrations by diesel vehicle traffic, and may modify acute cardiac effects of TRAP.

## S01.03A. Effects of Prenatal Exposure to Environmental Neurotoxicants on Health and Neurodevelopment

### S01.03.01. Tales from Two Cohorts

Deborah Dewey

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**Abstract: Background/Aim:** Developmental neurotoxicity is a global health concern. Neurotoxicants easily cross the placenta and fetal blood brain barrier, and their constant presence in maternal blood ensures that the fetus is exposed during critical periods of brain development. Exposure to neurotoxicants has been shown to be associated with children's neurobehavioural outcomes, which in turn has economic, social and health consequences. The aim of this presentation is to describe two large longitudinal pregnancy cohorts investigating associations between prenatal and childhood exposures to neurotoxicants and children's neurodevelopmental outcomes in a high (Canada) and a low income country (Tanzania). **Method and Results:** The Alberta Pregnancy Outcomes and Nutrition (APrON) cohort (2189 mothers) was recruited in Alberta, Canada. Data on prenatal exposure to endocrine disruptors (i.e., BPA, BPS, phthalates), heavy metals (i.e., methyl mercury, lead, arsenic, manganese) and perfluorooctane sulfonate (PFOS) during the second trimester of pregnancy has been collected for 563 children. In addition, we have collected biosamples at 3-4 years of age to assess childhood exposure levels. Children's neurodevelopment and behaviour at 2, 3-4 and 5-6 years is being assessed across multiple domains using standardized measures. The Mining and Health cohort (N = 1056) was recruited in Geita and Magu Districts, Tanzania where artisanal and small scale gold mining is a significant industry. In this cohort, data is being collected on prenatal exposure to mercury, arsenic and other heavy metals, pregnancy and birth outcomes, and early childhood health and development. **Conclusions:** These two pregnancy cohorts, one from a high income country and the other from a low income country, are providing much needed data on known and emerging neurotoxicants and their long term effects on children's health, neurodevelopment and behaviour.

### **S01.03.02. A Developmental Toxicology Model of Perfluorooctane Sulfonate and Methylmercury Co-Exposure**

Anthony Reardon

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**Abstract:** Background/Aim: Prospective birth cohort studies are powerful means of investigating associations between environmental chemical mixtures and neurodevelopmental outcomes in children, but there are few developmental toxicity studies in animal models with environmentally relevant chemical mixtures. We investigated the neurodevelopmental toxicity of methylmercury (MeHg), in the presence of an organic contaminant, perfluorooctane sulfonate (PFOS). These chemicals are two of the most ubiquitous contaminants in dietary fish, but little information is available on their toxicological interaction in neurodevelopmental models. Method: Pregnant Sprague-Dawley rats were exposed daily to PFOS (1mg/kg), MeHg (1mg/kg), Low PFOS+MeHg (0.1mg/kg, 1 mg/kg, respectively) or PFOS+MeHg (1 mg/kg, each) from gestation day 1 to weaning. Newborns were monitored for physical milestones and changes in innate behaviour. Juveniles underwent tests of spontaneous activity, anxiety, memory and cognition, and brain metabolomics (lipids, biogenic amines, amino acids). Results: Newborns from combined exposure groups had delayed responses and decreased weight gain. In contrast, juveniles showed evidence of chemical antagonism when individual exposure was compared to co-exposure. PFOS alone induced hyperactivity in the open-field and increased performance on the rotating rod but these effects were absent in the combined exposure groups. This antagonism was also noted in metabolomic analyses of rat cortex. Individual chemical exposures altered metabolomic profiles in a manner consistent with behavioural tests and specific changes in neurotransmitter (i.e. GABA) concentrations may account for the observed changes. Conclusions: Results demonstrate that neurodevelopmental effects from a simple binary mixture may vary with the developmental window examined, and that mixture effects are not necessarily predictable based on exposures to individual test substances.

### **S01.03.03. Prenatal Bisphenol A Exposure and Brain Structure in Preschool-Aged Children**

Melody Grohs

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**Abstract: Background/Aim:** In Canada, over 90% of the population has detectable levels of bisphenol A (BPA) due to dietary and non-dietary exposure. Human epidemiological studies have demonstrated behavioral effects of BPA exposure in children. Further, reported effects have been found to be sex-specific. Although behavioral outcomes have been examined, there is limited understanding of the effects of BPA exposure on children's brain structure. This study examined the effects of maternal BPA exposure on subsequent child white matter brain structure at 3 to 6 years of age. **Method:** Maternal total BPA concentrations in spot urine samples obtained during the second trimester of pregnancy were analyzed for 99 women. Their children participated in magnetic resonance imaging (MRI) between 3 to 6 years of age. Associations between prenatal BPA exposure and child fractional anisotropy and mean diffusivity within 10 isolated white matter tracts were investigated, controlling for sex and total maternal creatinine levels. Anisotropy and diffusivity provide measures of white matter structure and maturity. **Results:** Significant positive associations were observed between the level of prenatal BPA exposure and child white matter mean diffusivity within the splenium, and the right inferior frontal occipital, inferior longitudinal fasciculus, uncinate fasciculi, and pyramidal fibers. Significant sex differences were found, with more associations noted among females. No associations were observed between prenatal BPA exposure and child white matter anisotropy. **Conclusions:** Higher prenatal BPA exposure was related to higher mean diffusivity in white matter tracts at 3 to 6 years of age. Developmental studies show that with age, white matter anisotropy increases and diffusivity decreases in typically developing children. The current findings suggest that exposure to higher levels of BPA prenatally may be related to reduced white matter maturity in preschool aged children.

#### **S01.03.04. Prenatal Exposure to Bisphenol A and Bisphenol S and Neurodevelopment in Children at 2 Years of Age**

Jiaying Liu

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**Abstract:** Background/Aim: Bisphenol A (BPA) is an endocrine disruptor that is ubiquitous worldwide. Evidence suggests that it is a neurodevelopmental toxicant with sex-specific effects. Bisphenol S (BPS), an alternative to BPA, has been found to influence neurodevelopment in animal studies; however, human studies of BPS are limited. This study investigated the associations between prenatal exposure to BPA and BPS and child behaviour and neurodevelopment at 2 years of age, adjusting for maternal nutrient status, and co-exposure of heavy metals. The effect of child sex was also examined. Method: Total BPA and BPS concentrations were analyzed in spot urine samples from pregnant women in their second trimesters. Maternal neurotoxic metals and nutrient status/intake were evaluated using blood samples or dietary data collected during pregnancy. At age 2 years, children's neurodevelopment was assessed by the Bayley Scales of Infant and Toddler Development-Third Edition (Bayley-III; n=394) and behaviour was evaluated using the Child Behaviour Checklist (CBCL; n=358). Linear regression models were used to examine the associations between prenatal bisphenol exposure and Bayley-III scores and negative binomial regression was used for CBCL scores. Results: After adjusting for covariates, increasing BPA exposure was associated with poorer Social Emotional scores on the Bayley-III in boys ( $\beta=-5.1$ ; 95% CI: -9.6, -0.63) and higher scores on the attention problem subscale of the CBCL in all children ( $\beta=0.22$ ; 95% CI: 0.01, 0.43). Higher BPS exposure was associated with lower Motor scores on the Bayley-III for girls ( $\beta=-4.9$ ; 95% CI: -9.6, -0.20) and higher scores on the anxious/depressed subscale of the CBCL in all children ( $\beta=0.28$ ; 95% CI: 0.01, 0.54). Conclusions: Higher prenatal exposure to BPA and BPS was associated with poorer child development and more behavioural problems at age 2, with sex-specific effects on development.

### **S01.03.05. Environmental Contaminant Exposure during Pregnancy and Executive Function in 2 Year-Old Children**

Kayla Ten Eycke

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**Abstract:** Background/Aim: Bisphenol A (BPA) is an ubiquitous environmental chemical and research suggests it has neurotoxicant effects on neurodevelopment, including on executive functions (EF). Bisphenol S (BPS) is often used as a replacement for BPA, but may not be a safer alternative. This study examined associations among human prenatal exposure to BPA, BPS, and 5 common toxic heavy metals, and EF in children at 2 years of age. Method: Maternal urinary BPA and BPS, and blood heavy metals (i.e., cadmium, mercury, lead, arsenic, antimony) were measured during the second trimester of pregnancy in 352 women in the Alberta Pregnancy Outcomes and Nutrition (APrON) study. Children's EF at 2 years was assessed with the Behavior Rating Inventory of Executive Function-Preschool (BRIEF-P). Multiple regression models were run with time of urine collection, gestational age at urine collection, child sex, and household income as covariates. Results: Higher prenatal BPA, uncorrected for urinary creatinine, was associated with poorer BRIEF-P Shifting ( $\beta = .919$ ,  $t(351) = 2.149$ ,  $p = .032$ ) and Global Executive Composite scores ( $\beta = .976$ ,  $t(351) = 2.015$ ,  $p = .045$ ). Higher prenatal BPS, uncorrected for urinary creatinine, was associated with significantly higher Flexibility scores ( $\beta = -1.036$ ,  $t(351) = -2.151$ ,  $p = .032$ ). Effect sizes in creatinine corrected models were slightly smaller. Heavy metal exposures did not predict EF above and beyond the effects of BPA or BPS. Conclusions: These findings suggest that higher levels of prenatal BPA exposure are associated with poorer EF outcomes in children at 2 year of age. Higher prenatal exposure to BPS and other heavy metal contaminants were not associated with poorer EF outcomes in young children. Our results support the importance of examining the differential effects of prenatal exposures to various contaminants on neurocognitive outcomes in young children.

### **S01.03.06. Prenatal Exposure to Phthalates and Cognitive Outcomes in Early Childhood in the Apron Cohort**

Maede Ejaredar

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**Abstract: Background/Aim:** Phthalates are ubiquitous endocrine disrupting chemicals. Previous research suggests an association between prenatal maternal phthalate levels and adverse behavioural outcomes in children. However, no studies have investigated the association between prenatal phthalate exposure levels and cognitive outcomes in children 3 to 4 years of age. **Methods:** Twelve urinary phthalate metabolites were measured in urine collected in the second trimester from 416 women enrolled in the Alberta Pregnancy Outcomes and Nutrition (APrON) Study. Cognitive outcomes (IQ) of the children of these women were assessed at 3 to 4 years of age using the Wechsler Preschool and Primary Scale of Intelligence - Fourth Edition (WPPSI-IV). Associations between prenatal phthalate concentrations and children's cognitive outcomes were estimated using linear regression models. **Results:** Of the twelve urinary phthalate metabolites measured, eight metabolites showed statistically significant findings. After adjusting for gestational age, birth weight, maternal ethnicity, and maternal education, higher concentrations of both low molecular weight phthalate metabolites (miBP and mMP) and high molecular weight phthalate metabolites (mEHHP and mEHP) were associated with lower Full Scale IQ. Analyses of the WPPSI-IV subscales revealed that higher concentrations of the mBzP, mCOP, mECP, and mNP metabolites were associated with lower scores on Working Memory, Fluid Reasoning, Visual Spatial and Verbal Comprehension subscales of the WPPSI-IV. **Conclusions:** Higher prenatal maternal urinary metabolite concentrations of both low and high molecular weight phthalates were associated with poorer cognitive outcomes in children at 3 to 4 years of age. As phthalate exposures are widespread in the Canadian environment, these findings are of public health significance.

### **S01.03.07. Exposure to Arsenic and Mercury in Pregnant Women in Gold Mining Areas in Tanzania**

Elias Nyanza

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**Abstract: Background/Aim:** In Tanzania, artisanal and small scale gold mining (ASGM) operations expose entire communities to mercury and arsenic via the water they drink, the food they eat, the soil in which their food is grown, and the air they breathe. Prenatal exposure to mercury and arsenic is associated with reproductive risk factors including still birth, low birth weight, and congenital anomalies, and with poorer developmental outcomes in children. The Mining and Health study is investigating differences in prenatal exposure levels between women who live in ASGM areas and those who do not, and associated reproductive risk and early developmental outcomes of their children. **Method:** 1056 pregnant women were recruited during antenatal care clinic visits. For total mercury, a drop of whole blood was collected on filter paper (Whatman #903) following a simple finger prick to obtain a dried blood spot (DBS). For total arsenic, unprovoked morning urine samples were collected. DBS and urine samples were analyzed using inductively coupled plasma mass spectrometry. **Results:** Preliminary findings revealed that pregnant women with a history of living in an area with ASGM activities had blood mercury levels that were at least twice as high (95% CI: 0.54-2.4;  $p < 0.0001$ ) as women who had no history of living in ASGM areas. Living in an area with ASGM activities was associated with an increase in urine arsenic level of 54% (95% CI: 1.32-1.8;  $p < 0.0001$ ) compared to those not living in those areas. **Conclusions:** Living in ASGM communities was associated with higher blood total mercury and total arsenic levels in pregnant women. These higher blood levels could be associated with increased reproductive risk in the women and poorer neurodevelopmental outcomes in the children, which is the ongoing focus of this study.

## S01.03B. Food, Nutrition and Environmental Health among First Nations in Canada

### **S01.03.08. Critical Considerations in Environment and Health for First Nations**

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Abstract: The intersection of environment and health represents a unique set of considerations with respect to First Nations, many of which are informed by a deep attachment to land, language and culture. In the case of First Nations, the environment is generally not an external reality, but one inextricably tied to history, ceremony, subsistence and place. Environmental pollution places at risk not only First Nations' health - a critical aspect in its own right - but when a community can't fish or gather medicinal plants, for example, the impacts permeate well beyond health, potentially disrupting a complex tapestry that is best characterized by Indigenous Knowledge Systems (IKS). Where non-Indigenous peoples can elect to source alternate foods, or even relocate, First Nations are defined by their specific territories that are, in turn, reflected in their very identities. To buy fish or to move away disrupts the reciprocal relationships that many First Nations have with their particular environments - these are not interchangeable. As a result, adverse health outcomes arising from pollution are only one facet of the many unique challenges that may be faced by First Nations in Canada when environmental contaminants jeopardize food gathering and harvesting practices. This context will be explored at the outset of this session as a basis for a more meaningful appreciation of the topics thereafter.

### **S01.03.09. Food, Nutrition and Food Security in First Nations Communities**

Malek Batal

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Abstract: In the general Canadian population, household food insecurity is estimated at 9% and often cited as too high for a high-income country. In parallel, the First Nations Food, Nutrition and Environment Study (FNFNES), a 10-year study, investigated food security levels in 6487 households on 93 reserves across Canada south of the 60th parallel using the same tool in national Canadian surveys, the Household Food Security Survey Module (HFSSM) and found very high rates of food insecurity, ranging from a low of 29% in reserves in Ontario and a high of 47% in reserves in Alberta. These unacceptably high levels are associated with high levels of obesity (BMI  $\geq 30$ ) among adults (42%-52%) and equally high rates of self-reported diabetes (17-26%). Moreover, diets in all surveyed regions did not meet, on average, Health Canada's recommendations. In many First Nations communities, traditional food (TF), that is food harvested from the local environment, continues to hold a special cultural and spiritual importance, even if its consumption is low, relatively to food items purchased from the store. This low consumption can be explained by the many barriers reported by the survey participants (climate change, cost of equipment, lack of time, economic activities such as mining and agriculture, etc.). In addition, most participants reported desiring more TF in their diet, indicating another form of food insecurity associated with lack of access to TF. On the other hand, and despite the nutrition transition away from a traditional food system towards a diet dominated by store-bought foods, TF continues to contribute significantly to intakes of macronutrients and several micronutrients of concern in this population, highlighting its great nutritional importance. Preserving the quality of TF and ensuring access are of paramount importance if solutions to the worrying rates in food insecurity and chronic disease are to be found.

### **S01.03.10. The Legacy of Mercury Exposure in Grassy Narrows First Nation**

Donna Mergler

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Abstract: In 1960 and '70s, a plant in Northern Ontario dumped 10,000 tons of mercury (Hg) into the Wabigoon-English river system, which was used by the people of Asubpeeschoseewagong Netum Anishinabek (ANA, Grassy Narrows First Nation) for their livelihood (fishing guides, fisheries) and their main source of food. A large number of community members became ill; many with Minamata Disease. When fishing was stopped, they lost their jobs and a highly nutritious dietary mainstay. Hg in fish decreased over time until the mid-80's, but remains high. Concerned about the possible effects of historic and present Hg on their health and wellbeing, ANA undertook a Community Health Assessment (CHA), with the support of several federal and provincial ministries. The CHA survey questionnaire was based on the First Nations Regional Health Survey (2008/2010), with added questions on childhood and current fish consumption (indicators of Hg exposure) and health outcomes, known to be associated with Hg exposure. This allowed us to (i) compare the ANA responses to other First Nation communities on health, education, individual and community wellness, socio-economic status, food security and access to health care; (ii) examine the influence of past and present fish consumption on these outcomes. ANA community members organized the fieldwork; web-based surveys were filled out for 800 adults and children. Descriptive statistics were used to compare prevalence between ANA and other First Nation communities, and multivariate analyses were applied to examine the associations between fish consumption practices and the various outcomes. The study adopted the principles of Ownership, Control, Access and Possession (OCAP) of knowledge and information by the First Nation. In keeping with OCAP principles, the results of the study are presently (March - May) being shared and discussed in the community. In this communication, we will present the process and the major findings.

### **S01.03.11. Research and Monitoring Efforts on First Nations Environmental Health Issues**

Constantine Tikhonov

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Abstract: The First Nations and Inuit Health Branch, Health Canada/Indigenous Services Canada has been working on several large programs to assist First Nations in understanding and reducing the impact of exposure to chemical hazards in their environment: The First Nations Environmental Contaminants Program (FNECP); the First Nations Food, Nutrition and Environment Study (FNFNES) and the First Nations Biomonitoring Initiative. Initially, the Mercury Biomonitoring Program, which ran from 1970 to 2000, monitored exposure to mercury by collecting over 70,000 blood and hair samples in over 500 First Nation. The FNECP, created in 1999, supports community-based monitoring, research and risk assessment. Since 2000, the national FNECP has funded 103 national projects. Through dietary surveys and chemical exposure assessments and/or human biomonitoring, First Nations collaborated with researchers to gain important information on the chemical safety of their traditional diet. As appropriate, recommendations were made with respect to traditional food consumption. The FNFNES was created in 2008 to fill knowledge gaps on the diet and safety of traditional foods for First Nations living on-reserve south of the 60th parallel. This study was implemented region by region from 2008 to 2018. The FNFNES included five components: household interviews; drinking water sampling for trace metals; hair sampling for mercury; surface water sampling for pharmaceuticals and traditional food sampling for chemical contaminant levels. Results from the FNFNES mercury in hair sampling program will be compared to the findings of the earlier methylmercury biomonitoring program. Results from the FNFNES pharmaceutical sampling results will be explained in relation to how mixtures of pharmaceuticals can be characterized with respect to both their ecological and human health risks.

### **S01.03.12. Total Diet Exposure to Contaminants among First Nations Adults in Canada**

Laurie Chan

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Abstract: Indigenous peoples have elevated risks of exposure to environmental contaminants because of their traditional diet as some traditional foods, such as fish, wild game, and birds, have the potential to be contaminated with toxic chemicals. The objective of this study was to estimate dietary exposure to chemical contaminants among First Nations living on-reserve in Canada. A total diet study was constructed based on a 24-hour recall from the First Nations Food, Nutrition, and Environment Study (FNFNES) and contaminant concentrations in foods obtained through FNFNES for traditional foods and Health Canada for market foods. A probabilistic assessment of annual and seasonal traditional food consumption was conducted. This talk will present results from the latest assessments of contaminant exposure among First Nations in Canada and discuss the relationship with their health status.

**S01.03.13. Jeunes, Environnement Et Santé / Youth, Environment and Health (JES!-YEH!) Pilot Project in Four First Nation Communities in Quebec: Exposure Emerging Chemicals, Dietary Profiles and Health-Related Challenges**

Melanie Lemire

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Abstract: The pilot project Jeunes, Environnement et Santé / Youth, Environment and Health (JES!-YEH!) was conducted in 2015 among children and youth (3-19y, n=198) in collaboration with four First Nation communities in Quebec. Main findings show very low exposure to traditional foods related contaminants (metals and older persistent organic contaminants). However, in some communities, elevated exposure to perfluorononanoic acid (PFNA), bisphenol A, diethylphosphate, monobenzylphtalate and 2,5-dichlorophenol, at higher levels than in the Canadian Health Measure Survey for the same age groups, was found. Food insecurity and overcrowding was important in some communities. Overall, ultra-processed foods and sweet beverages were frequently consumed, and a high prevalence of iron deficiency, anemia, elevated blood manganese and obesity was found. These findings underscore the importance of better understanding the determinants of healthy eating environments in indigenous communities.

## S01.03C. High Resolution Air Pollution Mapping: Translating Data to Action

### S01.03.14. Personal Air Pollution Exposure Tracking: Bringing Data to Users

Roel Vermeulen

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Abstract: Large scale personal air pollution measurements are currently not feasible due to the lack of robust, affordable and accurate air pollution sensors. However, combining hyper-local air pollution maps with personal tracking information may provide an opportunity to derive personalized exposure estimates. We performed a study in which we overlaid GPS-tracking data (n=120) on time-resolved hyperlocal exposure maps (5 by 5m) of fine particulate matter (PM2.5) and soot (PM2.5 absorbance; PM2.5abs) and compared the derived personal estimates of PM2.5 and PM2.5abs to 24hr residential estimates and personal measurements of PM2.5 and PM2.5abs. The agreement (Concordance Correlation Coefficient) between personal measurements and residential estimates was 0.42 and 0.48 for PM2.5 and PM2.5abs, respectively. The agreement between personal PM2.5 and PM2.5abs estimates based on hyperlocal maps and GPS-tracks and measured personal 24-hr was 0.58 and 0.55, respectively. These results indicate that estimation of personal air pollution based on hyper local maps and GPS-tracks may provide reasonable valid individual predictions of air pollution that may be more accurate than only relying on air pollution estimates at the residential address. To facilitate personal air pollution tracking we have developed an App that allows near-real-time coupling of time-resolved air pollution maps with GPS-tracks. Such personalized information on air pollution can be used to inform the general and patient populations on air pollution conditions allowing for individual choices on when to undertake activities and where. In addition, the App allows users to report back on the living environment and their experiences, in order to update the information and to develop maps of perceived conditions of the living environment.

### **S01.03.15. Community Use of Stationary and Mobile Pollution Monitors in Somerville and Metropolitan Boston MA USA**

Wig Zamore

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Abstract: Over the last fifteen years, advocacy groups in Somerville and nearby communities have worked with environmental health research scientists and graduate students to study local air pollution and, more recently, noise patterns. These efforts can help inform community partners, policy leaders and regulatory agencies about serious environmental health risks. The results can help with land use and transportation decisions, and mitigation needs. Our community-based projects have ranged from short student practicums to formal multi-year research projects funded by NIH, EPA, HUD and Kresge Foundation. The practicums that we have engaged in have included consideration of turf vs natural athletic field exposures, lead in children's jewelry, community garden soil safety, bicyclist exposures and aviation noise patterns. In Somerville, a city of 80,000 with intense highway and diesel commuter rail exposures, we had the advantage of early near roadway pilot projects that used time integrated Nitrogen Oxide passive monitors and the Aerodyne Research mobile lab to show steep gradients of transportation related gases and ultrafine particle concentrations. This research, and public health records that showed a high correlation between surface transportation intensity and excess lung cancer and heart attack deaths, alerted us to the serious nature of transportation pollution. And to the need to bring local environmental health concerns to the forefront in policy and project decisions. Over the last decade we have also been engaged with Tufts and other universities in a series of near roadway research programs known as the Community Assessment of Freeway Exposure and Health (CAFEH). CAFEH has relied on intense mobile monitoring, assisted by stationary monitors, with a special focus on Ultrafine Particles, to relate biomarkers of cardiovascular risk in small populations to transportation sources. This research approach is difficult and might benefit from similar efforts at greater scale.

### **S01.03.16. Reducing Exposures to Traffic-Related Air Pollution in Urban Areas: Regional Planning, Neighborhood Design, and Individual Behavior**

Marianne Hatzopoulou

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**Abstract:** The assessment of exposure to traffic-related air pollution has seen advances along various dimensions. Air pollution dispersion models with fine spatial resolution and ability to reflect near-road air quality in street canyons, have made possible the development of exposure surfaces associated with strategic long-range scenarios affecting land-use and transportation in urban areas. Meanwhile, personal monitoring and GPS-enabled applications have motivated the development of a wide range of tools intended to inform users of their own exposure and ways to reduce it. While scientific evidence points to the success of these tools in identifying measures, at the policy or personal level, able to reduce air pollution exposures, there much left to learn about the impact of these tools on human behavior. How do policy makers use scenario-based information on air quality to formulate policy decisions? And how do individuals respond to air quality information provided to them? Are there individuals more inclined to respond to exposure reduction advice in a positive manner? This presentation will detail how high resolution air pollution data has informed a range of interventions to reduce traffic-related air pollution exposures in Canadian cities, from clean routes applications to large investments in transportation infrastructures and urban design. New evidence will also be presented from a stated-preference experiment examining how air pollution information impacts individual behavior.

### **S01.03.17. Street-Level Air Pollution, Health Disparities, and Advocacy**

Maria Harris

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**Abstract:** Recent mobile monitoring and high density distributed network campaigns have provided unprecedented insight into intra-neighborhood air pollution variability in Oakland, CA. A study examining these data in relation to health records found that elderly residents with higher levels of traffic-related pollution in the immediate vicinity of their homes had elevated cardiovascular risks. West Oakland Environmental Indicators Project, a local environmental justice organization, in partnership with Environmental Defense Fund, a large environmental non-profit, is leading efforts to use these findings to influence community, city, and state level efforts to address harmful air pollution. Several important learnings have emerged from our work to date. First, community residents with experiential understanding of local air pollution sources are key partners in interpreting hyperlocal pollution data. Community partners are also the most credible and trusted communicators of data to local residents, and the most effective advocates for local policy change. Second, messaging around air pollution-related health impacts and inequities at the street and block level can be particularly effective in engaging a broad range of stakeholders. Findings must be communicated in clear and compelling terms, and "scientific interpreters" can help accurately represent scientific findings in suitable language and formats. Finally, efforts to translate study results to action require long-term commitment and follow-through - preliminary data and findings should be shared with community partners as early as possible and ongoing support and collaboration must continue long after research is completed. These elements: trust-based partnerships with local advocates, effective communication, and long-term engagement, require substantial investment of resources beyond those required to conduct traditional research, but are core to enabling translation of hyperlocal air pollution data to action.

### **S01.03.18. Rapid-Response Local Monitoring of Toxic Air Pollution after Hurricane Harvey**

Anthony Miller

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**Abstract:** Natural disasters pose unique chemical exposure risks. In August of 2017, Hurricane Harvey slammed into Houston, dumping 275 trillion tons of water that flooded the Houston area. As the Houston area is home to roughly 570 chemical plants, 43 Superfund sites, nine refineries, 188 cement batch plants, 80 metal recycling facilities, one of the largest ports in the nation, and the 25-mile long Houston Ship Channel, the flood damage was severe. As a result, Houston's petrochemical industry released millions of pounds' worth of harmful pollution into the air. The state agency responsible for protecting the environment in Texas had shut down equipment measuring air contaminants in an attempt to protect air quality monitors from storm-related water and wind damage. The region's lack of zoning laws means that many industrial facilities in the region sit adjacent to schools and residential neighborhoods. With state and federal air pollution monitors off-line because of the storm, Environmental Defense Fund hired Entanglement Technologies to deploy a prototype AROMA analyzer to perform mobile surveys of atmospheric volatile organic carbons (VOCs) in areas where storm-related pollution releases had been reported. AROMA provided a real-time speciated VOC analysis. The mobile survey identified two significant plumes of benzene, a known carcinogen, and several additional plumes with lower toxicological risk. Field measurements identified source areas, provided exposure information for impacted residential areas, and assessed the impact of variable atmospheric conditions on dispersion of pollutants. AROMA measurements corroborated measurements taken by the City of Houston and resulted in an ongoing investigation of a petrochemical facility for underreporting of emissions and permit violations. This mobile campaign demonstrated the value of high resolution, rapid response data for allocating scarce government measurement resources to protect impacted communities.

## 001.04A. Air Pollution, Asthma and Allergic Disease

### **001.04.01. Association of Air Pollution with Incidence of Asthma, Allergic Rhinitis and Eczema: 10-Year Follow-Up of the Toronto Child Health Evaluation Questionnaire (T-CHEQ) Study**

Dave Stieb

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**Abstract:** Objective: To examine the associations between ambient nitrogen dioxide (NO<sub>2</sub>) and ozone (O<sub>3</sub>) exposures at birth and incidence of asthma, allergic rhinitis and eczema in childhood through adolescence. Methods: In the 2006 Toronto Child Health Evaluation Questionnaire study, 5,619 children aged 5-9 were recruited from randomly-selected public schools in Toronto, Ontario. Participants were included in this study if they were born in Ontario and consented to have their health card number used for data linkage. Yearly mean values of NO<sub>2</sub> and O<sub>3</sub> were acquired from air pollution fixed monitoring stations and assigned to participants based on their postal codes at birth, using inverse distance weighting. The primary outcome, physician-diagnosed asthma, was measured using a validated health administrative definition. Secondary outcomes, allergic rhinitis and eczema, were measured by any health services use for these conditions. Participants were followed from birth until outcome, March 31, 2016, or loss-to-follow-up. Multivariable Cox proportional hazard regression models were used to estimate the associations between air pollutants and outcomes, adjusting for potential confounding variables. Results: 1,881 children were followed from birth for an average of 13 years. 31% of children developed asthma; average age at asthma incidence was 3 years. A 10-unit increase in exposure to O<sub>3</sub> at birth was associated with an 82% increased hazard of asthma (HR: 1.82; 95%CI: 1.05, 3.18), while exposure to NO<sub>2</sub> was not associated with asthma (HR: 1.02; 95%CI: 0.53, 1.98). O<sub>3</sub> was also associated with increased hazard of allergic rhinitis and eczema. Conclusion: Ambient O<sub>3</sub>, but not NO<sub>2</sub>, was associated with a significantly increased risk of incident asthma, allergic rhinitis and eczema. This suggests that improving air quality and increasing awareness about the risks of air pollution may have beneficial effects on the prevention of asthma and other allergic disease.

## **O01.04.02. Meta-Analysis of Associations between Air Pollution and Childhood Eczema, Rhinoconjunctivitis and Asthma in Four European Birth Cohorts**

Elaine Fuertes

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**Abstract:** Background: How early-life and current exposures to air pollution affect allergic and respiratory health development remains unclear. Objective: We examined associations between traffic-related air pollution levels and childhood eczema, rhinoconjunctivitis and asthma prevalences in 4 European birth cohorts from 6 centers (EDEN, INMA (Sabadell, Gipuzkoa, Valencia), RHEA and ROBBIC-Rome). Methods: Eczema, rhinoconjunctivitis and asthma were assessed in children aged 4 (N =4262 from 6 centers) and 7/8 years-old (N =3365 from 5 centers) using MeDALL-harmonized outcome definitions. A multi-morbidity outcome (any condition versus none) was also defined. Land-use regression models, based on air pollution monitoring data collected near the time of cohort recruitment, were used to estimate individual outdoor levels of nitrogen dioxide (NO<sub>2</sub>), nitrogen oxides, particulate matter with an aerodynamic diameter < 10 µm, between 10 µm and 2.5 µm, and < 2.5 µm (PM<sub>2.5</sub>), as well as PM<sub>2.5</sub> absorbance, to the birth, 4- and 7/8-year home addresses. Cohort-specific associations were assessed using adjusted logistic regression models and combined in a random effects meta-analysis. Results: Overall, the estimated air pollutants and health outcomes were not associated, regardless of the age or home address considered (e.g. meta-analysis odds ratios [95% confidence intervals] for asthma at 4 and 7/8 years were 0.85 [0.67, 1.06] and 0.96 [0.71, 1.30] per 10 µg/m<sup>3</sup> increase in NO<sub>2</sub> estimated to the birth address, respectively, and 0.81 [0.41, 1.59] and 0.58 [0.28, 1.20] per 5 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> estimated to the birth address, respectively). We observed little heterogeneity across cohorts. Conclusion: Despite reducing outdoor exposure misclassification at the home address by using air pollution estimates derived from data

collected near the time of birth, we did not find associations between traffic-related air pollution levels and childhood eczema, rhinoconjunctivitis or asthma prevalences.

### **O01.04.03. Effects of Fine Particulate Matter and Its Constituents on Asthmatic and Allergic Symptoms in Preschool Children: A Cross-Sectional Study in Six Cities of China**

Wenming Shi

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**Abstract:** Background/Aim: Few studies examined the effects of specific PM<sub>2.5</sub> constituents on childhood asthma and allergy in China. We aimed to investigate the effects of various PM<sub>2.5</sub> constituents on asthmatic and allergic symptoms in preschool children in China. Methods: A cross-sectional study was conducted among 48219 preschool children in six cities (Shanghai, Nanjing, Chongqing, Changsha, Urumqi and Taiyuan) based on China , Children ,Home and Health (CCHH) project in China. Information on allergic symptoms as well as demography were collected by questionnaires. Data for ambient PM<sub>2.5</sub> concentration and its 5 constituents: BC, NH<sub>4</sub><sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup> and OC were obtained from the global burden disease project to 205 kindergartens at a spatial resolution of 0.01×0.01(1km×1km) in six cities. A hierarchical logistic regression model was performed to explore the associations between kindergarten-level PM<sub>2.5</sub> components and individual-level outcomes of asthmatic and allergic symptoms controlling for demography and other covariates. Results: A total of 30759 participants (51.7% male) were finally completed the study due on the missing data. Both the single-pollutant and two-pollutants model showed that ambient PM<sub>2.5</sub> per 10ug/m<sup>3</sup> increase positively associated with the prevalence of diagnosed asthma by an adjusted odds ratio (AOR) and 95% confidence interval(CI) of 1.18(1.01-1.35) and 1.13(1.02-1.24), respectively. Furthermore, the concentration of SO<sub>4</sub><sup>2-</sup> and NO<sub>3</sub><sup>-</sup> were significantly associated with the prevalence of asthma and current rhinitis by the AOR for each 1ug/m<sup>3</sup> increase in SO<sub>4</sub><sup>2-</sup>, and NO<sub>3</sub><sup>-</sup> concentrations of 1.09(1.03-1.15) for asthma and 1.04(1.00-1.07) for current rhinitis, respectively. Conclusion: Components of PM<sub>2.5</sub>, especially NO<sub>3</sub><sup>-</sup> and SO<sub>4</sub><sup>2-</sup> exposure were associated with asthmatic and allergic diseases in preschool children in China. Considering the related sources and combustion, it may represents an preventable risk factor for childhood asthma and allergic diseases.

#### **O01.04.04. Exposure to Traffic-Related Air Pollution and Risk of Development of Childhood Asthma: Results from the Born in Bradford Cohort Study**

Haneen Khreis

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**Abstract:** Background Childhood exposure to traffic-related air pollution (TRAP) might lead to the onset of new childhood asthma. However, there has been little study of the modifying effect of ethnicity especially among South Asians. We aimed to evaluate the relationship between residential exposure to TRAP and new-onset asthma in the multi-ethnic Born in Bradford cohort study. **Methods** Using validated land-use regression models developed in the ESCAPE project (European Study of Cohorts for Air Pollution Effects), we estimated annual average childhood exposures to NO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>, PM<sub>2.5</sub> absorbance, PM<sub>10</sub>, and PM<sub>coarse</sub> at the birth residence. As another TRAP exposure metric, we also estimated traffic intensity within 100m buffer and traffic intensity on the nearest major road. New childhood asthma cases were identified based on diagnostic codes entered by general practitioners onto the primary care databases of the 11032 eligible children. We used Cox proportional hazard models, adjusted for key confounders, to evaluate the relationship between residential exposure to TRAP and new-onset asthma. We then stratified the analysis by the mother's ethnic group. **Results** We found multiple positive and statistically significant associations between the exposure to the different pollutants and the new onset of asthma. The associations with the traffic intensity indicators were null. Stratifying the analysis by "White British" and "Pakistani" ethnicities revealed that the associations were stronger or restricted to the Pakistani children. This was especially prominent in association with the exposure to PM<sub>2.5</sub> absorbance, a specific traffic marker. **Conclusion** Our results suggest that associations between TRAP exposures and new-onset asthma differ between White British and Pakistani origin infants.

### **O01.04.05. Emergency Department Visits among Patients with Eosinophilic Esophagitis and Acute Exposures to Particulate Pollution (PM2.5)**

Melissa Maestas

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Abstract: Research suggests that environment plays a significant role in the presentation of eosinophilic esophagitis (EoE), an allergic disease affecting the esophagus, resulting in inflammation and esophageal symptoms. Aeroallergens are known to exacerbate EoE. Additional aeroantigens, such as air pollution, have been postulated to exacerbate EoE. We examined emergency department (ED) visits among EoE patients and acute exposures to ambient particulate air pollution (PM2.5). Retrospective case crossover analyses of ED visits among EoE patients (January 2000 - May 2014) were performed using data from the Utah Population Database, University of Utah Health Sciences Center, and Intermountain Healthcare and ambient air pollution data. Two separate methods were used to estimate PM2.5 exposure: 1) kriging of local monitoring stations and 2) assigning the observations from the closest monitor (limited to EoE patients living within a pre-specified distance to the closest monitor). We controlled for ozone, nitrogen dioxide, and temperature. The cohort included 4,381 EoE patients, 242 of whom had ED visits. The odds ratio (OR) of ED visit among EoE patients for chest pain, dysphagia, and/or esophageal impaction with PM2.5 above 35 µg/m<sup>3</sup> on at least one day during the preceding week was 2.79, 95% confidence interval (CI) 1.04-7.46 using the kriging method for 131 ED visits that could be assigned PM2.5 data. Using the closest monitor estimation method, the OR was 2.96, 95% CI 1.07-8.25 for 76 ED visits that could be assigned PM2.5 data. Restricting the analysis to ED visits for dysphagia and/or impaction were significant for the kriging method, but not closest monitor. In this study using individual-level case-crossover analysis, we find evidence that acute exposures to PM2.5 is associated with exacerbations of EoE. Further research into the effects of air pollution on EoE is warranted, with careful consideration of the method used to assign pollution data to patient data.

## O01.04B. Application of Machine Learning Methods to Develop Spatiotemporal Models of Air Pollution

### **O01.04.06. Generalization of Constrained Mixed-Effect Modeling Framework with Ensemble Learning to Broader Geographic Areas for Predicting Nitrogen Oxides at High Spatiotemporal Resolution**

Rima Habre

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**Abstract:** Background: Spatiotemporal models developed for a specific region typically provide high spatial and temporal resolution in predicting exposures locally; however, it is challenging to directly apply them to broader regions in large epidemiological studies. Aim: To extend our southern California (CA) nitrogen oxides (NO<sub>x</sub>) spatiotemporal modeling framework (Li et al., 2017) to the entire state, evaluate its performance, and recommend key parameters to tune for future spatiotemporal model extension applications. Methods: In addition to our southern CA model data, we incorporated data from 105 ambient monitoring stations to cover CA. We conducted sensitivity analyses to determine the optimal number and aggregation distance to use in reconstructing temporal basis functions (temporal variability) and Thiessen polygons (spatial effects), respectively. We conducted ensemble and 10-fold cross validation (CV) to determine model prediction performance against from long-term ambient monitoring data and from short-term independent measurement campaigns. Results: We achieved an ensemble learning CV R<sup>2</sup> of 0.88 for both our NO<sub>2</sub> and NO<sub>x</sub> CA-wide global models. Without considering regional differences, global models had slightly diminished performance (R<sup>2</sup> reduced ~9% for NO<sub>2</sub> and 4% for NO<sub>x</sub>) than region-specific models for southern CA. Sensitivity analyses showed that 4-6 temporal basis functions and a smaller aggregation distance (200 m) ensured that the global model captured a wider range of temporal and spatial patterns in NO<sub>2</sub> and NO<sub>x</sub> variability, respectively. Additional temporal basis functions may result in overfitting and smaller aggregation distances severely impact computational time with minor incremental improvement in model performance. Conclusions: This study illustrates the importance of accounting for regional differences for tuning local, region-specific models such that they can be applied to larger areas.

### **001.04.07. An Ensemble Machine-Learning Model to Predict Historical PM2.5 Concentrations in China from Satellite Data**

Guannan Geng

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**Abstract:** Background: The long satellite aerosol data record enables assessments of historical PM2.5 level in developing countries such as China where routine PM2.5 monitoring began only recently. However, most previous models reported decreased prediction accuracy when predicting PM2.5 levels outside the model-training period. This limitation greatly hinders the application of satellite-driven exposure assessments in the research on health effects of long-term PM2.5 exposure. Objectives: We proposed an ensemble machine learning approach that provided reliable PM2.5 hindcast capabilities in China. Methods: Non-random missing satellite data due to cloud cover were first filled by multiple imputation to ensure unbiased long-term exposure estimates. Then the modeling domain, China, was divided into seven regions using a spatial clustering method to control for unobserved spatial heterogeneity. A set of machine learning models including random forest, generalized additive model, and extreme gradient boosting were trained in each region separately. Finally, a generalized additive ensemble model was developed to combine predictions from different algorithms. Results: The ensemble prediction characterized the spatiotemporal distribution of daily PM2.5 well with the cross-validation (CV) R2 (RMSE) of 0.79 (21  $\mu\text{g}/\text{m}^3$ ). The cluster-based sub-region models outperformed national models and improved the CV R2 by  $\sim 0.05$ . Compared with previous studies, our model provided more accurate hindcasts at the daily level (R2 = 0.53, RMSE = 28  $\mu\text{g}/\text{m}^3$ ) and monthly level (R2 = 0.81, RMSE = 13  $\mu\text{g}/\text{m}^3$ ). Conclusions: Our hindcast modeling system allows for the construction of long-term, unbiased historical PM2.5 levels that can support epidemiologic studies on the chronic health effects of PM2.5 in China.

#### **O01.04.08. Leveraging Google Place of Interest (POI) Data, Crowdsourcing, and Machine Learning to Predict Urban NO<sub>2</sub> Concentrations for the Contiguous U.S.**

Tianjun Lu

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**Abstract:** Background: Land Use Regression (LUR) has been extensively applied to model intra-urban variations of air quality across the US. Predictor variables are typically derived from government sources (e.g., US Census) and do not include detailed information on land use or urban form. We developed LUR models that combine enhanced data on urban form and land use with machine learning to compare to traditional LUR models. Methods: Our LUR models are based on data from three sources: (1) a crowdsourced measure of urban form, (2) land use information derived from Google Place of Interest (POI) data, and (3) satellite observations of air quality. We developed models using US EPA NO<sub>2</sub> monitoring data (n=426 locations) during 2010-2015. The measure of urban form (Local Climate Zones [LCZs]) was obtained using a crowdsourcing platform (Amazon Mechanical Turk) to allow multiple users (n=10) to classify satellite imagery into 17 categories of urban development (e.g., compact; sprawl). We web-scraped Google POI data (e.g., gas stations; restaurants) at various buffers (100-1,000 meters) to add detailed information on land use. We also included satellite observations of NO<sub>2</sub> abundance. Using only these variables, we developed LUR models using both conventional (stepwise regression) and machine learning (e.g., bagging; gradient boosting). Results: Model fit was better for the machine learning models (gradient boosting; R<sup>2</sup>: 0.59; mean absolute error [MAE]: 2.46) as compared to the conventional models (i.e., stepwise regression; R<sup>2</sup>: 0.39 and MAE: 3.35) when using only the LCZ urban form measure and satellite NO<sub>2</sub> abundance. Adding Google POI data improved model fit. For gradient boosting model-R<sup>2</sup> increased to 0.65 (MAE: 2.28); model-R<sup>2</sup> increased to 0.61 for stepwise regression (MAE: 2.34). Conclusions: Our work suggests that using generalizable data on urban form (e.g., Google POI; LCZs) to develop LUR models may produce similar results to models developed using conventional data sources.

## **O01.04.09. Developing Advanced PM2.5 Exposure Models in Lima, Peru**

Bryan Vu

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**Abstract:** Background: There is convincing evidence of adverse health effects induced by exposure to PM2.5 in the growing body of literature. Lima's topography and aging vehicular fleet results in severe air pollution with limited amounts of monitors to effectively quantify measurements for epidemiologic studies. Objectives: We propose to develop a high-performance satellite-driving exposure model to estimate daily PM2.5 concentrations at a 1 km spatial resolution in Lima, Peru from 2010 to 2016 using a combination of ground measurements, aerosol optical depth (AOD), meteorological fields, parameters from atmospheric chemical transport models, and land use variables. Methods: Parameters from the Weather Research and Forecasting model coupled with Chemistry (WRF-CHEM) and the European Centre for Medium-Range Weather Forecasts (ECMWF) were evaluated against ground monitoring stations from Weather Underground. A random forest model was used to gap-fill non-random missing satellite AOD data due to cloud cover to enhance spatial coverage and quality. Both a linear mixed effects model and a random forest model was used to fit AOD, WRF-CHEM, ECMWF, meteorological fields, and land use parameters against ground measurements from 16 monitoring stations with available data between 2014 to 2016. Both models were then used to estimate daily PM2.5 concentrations from 2010 to 2016. Results: The overall cross-validation (CV) R2 value and (RMSE) for the linear mixed effects model and random forest model was 0.58 (7.08 µg/m3) and 0.73 (5.66 µg/m3), respectively. The random forest model's robust ability to include more parameters outperformed the linear mixed effects model due to limited number of ground observations. Conclusions: Our models allow for construction of long-term historical daily PM2.5 levels to support fundamental and imperative epidemiological studies that will likely impact governmental policies on air quality in Lima, Peru.

#### **001.04.10. Assessment of Shared and Unshared Exposure Measurement Error in Ensemble Learning Estimates of Nitrogen Oxides and Its Implications on Epidemiological Findings in Air Pollution Studies**

Mariam Girguis

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**Abstract:** To improve exposure spatial and temporal resolution, researchers are using machine learning spatiotemporal air pollution models for large cohort studies. We aim to (1) measure shared, unshared, multiplicative, and additive (SUMA) measurement error in a three-stage (mixed effect ensemble learning with constrained optimization) spatiotemporal nitrogen oxides (NO<sub>x</sub>) model and (2) assess the impact of shared error and advanced exposure algorithms on epidemiological results. By treating NO<sub>x</sub> ensembles as realizations from an external dosimetry system, we quantified SUMA measurement error by extracting variance and covariance elements across realizations. To identify geographic locations with significantly elevated error, we used generalized additive models with a smooth term for location. We iteratively analyzed the risk of recent wheeze and NO<sub>x</sub> exposure among children using predictions from each stage of the NO<sub>x</sub> model to assess incremental influences of modeling stages on epidemiological conclusions and adjusted for shared error. We found evidence of both shared and unshared multiplicative error ( $p < 0.01$ ) in our spatiotemporal NO<sub>x</sub> predictions. Findings indicate that unshared multiplicative error is 25.8 times larger than the shared multiplicative error. Significant geographic variation of shared multiplicative error was observed ( $p = 0.0004$ ) and the majority (41%) of all predictions with high shared multiplicative error were observed in the earliest prediction period, 1992-2000. Depending on the exposure output used, the wheeze odds ratio for an interquartile range increase in NO<sub>x</sub> exposure ranged from 1.16-1.29. The standard error increased from 0.0049 to 0.0053 when accounting for shared multiplicative error. Spatial and temporal patterns of shared multiplicative error were mostly observed in densely populated urban regions with complex air pollution sources. Epidemiological conclusions were minimally affected by shared multiplicative exposure measurement error.

## 001.04C. Neurological and Cognitive Outcomes Associated with Air Pollution

### **001.04.11. Brain Metabolite Levels May Mediate Traffic-Related Air Pollution Associated Generalized Anxiety Symptoms: Findings from the Cincinnati Childhood Allergy and Air Pollution Study**

Kelly Brunst

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**Abstract:** Introduction: Exposure to traffic-related air pollution (TRAP) is associated with cognitive and neurobehavioral outcomes. The impact of TRAP on brain metabolism and the role of these in childhood anxiety is unknown. Methods: Adolescents (N=145, aged 11-15 years) underwent neuroimaging as part of the Cincinnati Childhood Allergy and Air Pollution Study. Brain metabolite levels- including myoinositol (mI), N-acetylaspartate (NAA), creatine (Cr), choline (Cho), glutamate (Glu), glutamate plus glutamine (Glx), glutathione (Gsh) - were measured in the anterior cingulate cortex using magnetic resonance spectroscopy (MRS). The Spence Children's Anxiety Scale assessed generalized anxiety symptoms. Average exposure to TRAP during the last 12 months was estimated using a validated land use regression model. Linear regression was used to assess TRAP effects on brain metabolite levels and anxiety symptoms. A bootstrapping method was used to test for mediation by brain metabolite levels. Models were adjusted for race, family income, maternal age at delivery and depression, hair cotinine, and parental relation frustration. Results: High TRAP exposure (> 75th %) was associated with significant increases in Glx ( $\beta = 0.62$ ; 95%CI 0.06, 1.18), Glu ( $\beta = 0.32$ ; 95%CI 0.04, 0.60), Cho ( $\beta = 0.08$ ; 95%CI 0.01, 0.15), and mI ( $\beta = 0.25$ ; 95%CI 0.01, 0.50) compared to low TRAP exposure ( $\leq 75$ th %). High TRAP exposure ( $\beta = 3.47$ ; 95% CI 0.62, 6.33) and increased mI levels ( $\beta = 2.09$ ; 95% CI 0.21, 3.96) were significantly associated with more generalized anxiety symptoms. The mediation analysis suggests that 13% of the total effect between TRAP and generalized anxiety symptoms was mediated by mI levels ( $\beta$  indirect effect = 0.43; 95% CI 0.41, 0.46). Conclusions: TRAP-associated increases in metabolite levels suggest possible excitatory neurotransmission, membrane disruption, active gliosis, and inflammation. Disruption in mI levels might be an important pathway linking TRAP and anxiety in adolescents.

## **O01.04.12. Effects of Traffic Related Particulate Matter on Behavior, Inflammation, and Neuronal Tract Integrity in a Developmental Rodent Model**

Ben Nephew

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Abstract: There is convincing evidence that living close to major roadways and highways is associated with increased morbidity and mortality. Data indicate that traffic-related air pollution (TRAP) contributes to these adverse health outcomes near traffic sources, and particulate matter (PM) is elevated in TRAP. Animal toxicology studies as well as recent human epidemiology suggest that exposure to PM affects cardiovascular health and the nervous system. There is increasing epidemiological evidence of neurological effects including white matter loss, impaired cognition in the young and old, depression and anxiety, and teenage delinquency. Etiologically relevant animal studies can strengthen the case for the biological plausibility of these epidemiological associations. Therefore, we have recently developed a novel rodent model of developmental exposure to TRAP associated PM where gestating and lactating rats are chronically exposed (5 hrs/day, 5 days/week for 6 weeks) to epidemiologically relevant levels of PM (PM<sub>2.5</sub> and UFP, <100nm) from Boston area traffic tunnels. Following this exposure, the behavior, peripheral immune activity, and neuroanatomy (with ex vivo anatomical and diffusion tensor neuronal track targeted MRI) of juvenile male offspring were assessed. Compared to low ambient PM exposed controls, TRAP PM exposed offspring exhibited increased fear/anxiety ( $p=0.04$ ,  $d=1.0$ ,  $p<0.01$ ,  $d=1.6$ ), impaired group ( $p<0.01$ ,  $d=1.5$ ) and pairwise ( $p=0.04$ ,  $d=0.9$ ) social behavior, deficient nest building ( $p=0.04$ ,  $d=1.0$ ), an altered gastrointestinal response to novelty stress ( $p<0.01$ ,  $d=1.4$ ), and changes in neuronal tract integrity. Immune assessments are ongoing. It is concluded that this is a valuable naturalistic model to test the adverse effects of TRAP PM on neurobehavioral health, and increased research on neuroendocrine/neuroinflammatory mechanisms is warranted.

### **O01.04.13. The Role of Cardiovascular Disease in the Relationship of Chronic Exposure to Air Pollution and Incident Dementia**

Sindana Ilango

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**Abstract:** **BACKGROUND:** Cardiovascular disease is a known determinant of dementia. Epidemiologic studies have also shown that chronic exposure to air pollution may play a role in the development of dementia and cardiovascular disease. This motivated us to apply a formal causal mediation analysis to examine the relative contribution of cardiovascular disease to the relationship between air pollution and incident dementia. **METHODS:** A population-based cohort comprised of Canadian-born residents of Ontario, Canada who participated in the Canadian Community Health Surveys from 1996-2003 were followed through 2013 or until dementia diagnosis. Chronic exposure to selected ambient air pollutants (i.e., fine particulate matter [PM<sub>2.5</sub>] and nitrogen dioxide [NO<sub>2</sub>]) was assessed using a 3-year running average with a 5-year lag before dementia diagnosis. Incident cardiovascular disease occurring prior to dementia was evaluated as a potential mediator. We used multi-level Cox proportional hazard regression models, adjusting for individual- and neighborhood-level risk factors (e.g., smoking, physical activity, education, and neighborhood income), to estimate hazard ratios (HR) for every interquartile range increase in exposure to PM<sub>2.5</sub> and NO<sub>2</sub>. We estimated the total, direct, and indirect effects of air pollution on incident dementia and the proportion mediated through cardiovascular disease. **RESULTS:** The risk of dementia was moderately higher among those exposed to NO<sub>2</sub> (HR=1.08 95% CI=1.00, 1.16) and PM<sub>2.5</sub> (HR=1.15 95% CI=0.93, 1.41) after adjusting for covariates. We estimate 9.0% and 21% of the observed association between NO<sub>2</sub> and PM<sub>2.5</sub>, respectively, and dementia to be mediated through cardiovascular events. **CONCLUSION:** These results suggest that some of the association between chronic air pollution and dementia is mediated through its effect on cardiovascular disease. Improving cardiovascular health may prevent dementia in areas with higher exposure to air pollution.

## O01.04D. Novel Approaches in Environmental Epidemiology

### **O01.04.15. Case Time Series: A Novel Study Design for Big Data Analyses in Environmental Epidemiology**

Antonio Gasparrini

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**Abstract:** Environmental research has been transformed by big data technologies, such as electronic health records linkage, wearables and remote sensing. These tools provide the opportunity to perform large population-based studies, with longitudinal collection of individual-level variables and finely reconstructed spatio-temporal exposure maps. However, these studies require innovative analytical methods. Here we present a new study design called case time series for investigating transient health risks in epidemiological analyses. The design is based on the reconstruction of longitudinal profiles of health outcomes and time-varying predictors in subject-specific series. This adaptable framework combines the individual-level setting and confounding control of case-only methods, such as case-crossover and self-controlled case series, with the flexibility and temporal structure of time series methods to model trends and lagged effects. It is applicable with either continuous or (multiple) event outcomes. Estimation exploits the computational efficiency of conditional regression models. Applications are demonstrated through three case studies that illustrate flexibility and wide applicability of the design: 1) analysis of associations between air pollution and asthma recurrence using a general practitioners patients cohort; 2) country-wide study of temperature-mortality associations using small-area data and high-resolution exposure maps; 3) analysis of effects of weather on musculoskeletal pain in a cohort of patients, with daily questionnaires and geo-located exposures collected through a smartphone app. The case time series design combines several advantages, such as an individual-level setting, strict confounding control, modelling flexibility, and computational efficiency. Its longitudinal structure allows investigation of complex temporal dependencies and the definition of individual risk profiles, making full use of new big data resources for environmental studies.

## **O01.04.16. Expose: An R Package for Estimating Individual and Average Joint Effects of Chemical Mixtures, Dose-Response Relationships, and Potential Interactions in Environmental Epidemiology**

Ibon Tamayo

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**Abstract:** Introduction: Although the general population is exposed to multiple chemicals, most environmental epidemiology studies consider each chemical separately when estimating the adverse effects of environmental exposures, partly because of the lack of software accessible to environmental epidemiologists. Objective: We developed a statistical R package, accessible to environmental health scientists that can provide valid estimates for effects of environmental contaminants, dose-response relationships, and interactions in a multi-pollutant setting. Methods: This package implements the work of Oulhote et al (2017) that combines the G-formula, a maximum likelihood estimator, with the ensemble learning technique Super Learner. It incorporates a wide range of statistical techniques (e.g. generalized linear and additive models, random forest, extreme gradient boosting) to estimate and provide valid inference in multi-pollutant settings and reconstruct dose-response relationships non-parametrically. Results: This package will facilitate multi-pollutant analysis of environmental epidemiology. We also developed a user-friendly Shiny application that can be used by biomedical researchers modeling complex mixtures. We ran multiple simulations based on real scenarios and the proposed method yielded promising results across all the scenarios. Our approach was also able to estimate the true underlying structure of the data. We will present a tutorial describing the package functions and visualizations to illustrate our developed methods. Conclusion: This package will help to unravel the effects of chemical mixtures and their interactions in epidemiological studies. Youssef Oulhote, Marie-Abele Bind, Brent Coull, Chirag, Patel, Philippe Grandjean. 2017. Combining Ensemble Learning Techniques and G-Computation to Investigate Chemical Mixtures in Environmental Epidemiology Studies. Biorxiv. <https://www.biorxiv.org/content/early/2017/06/30/147413.article-info>

## **O01.04.17. Influence of the Urban Exposome on Birth Weight**

Mark Nieuwenhuijsen

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**Abstract:** Background: We aimed to evaluate the association of the urban exposome with birth weight and term low birth weight. Methods: We estimated exposure to the urban exposome, including the built environment, air pollution, noise, meteorology and natural space (corresponding to 75 exposure variables covering 30 exposure groups ) for nearly 32,000 pregnant women from 6 European birth cohorts. We used two different statistical methods to evaluate possible associations with either continuous birth weight or term low birth weight risk: An exposure-by-exposure method accounting for multiple hypotheses testing, the so called exposure wide association studies (ExWAS) and one method Deletions-Substitution-Addition (DSA), algorithm accounting for correlated exposures. Results: The most consistent statistically significant associations across the statistical analyses were for green space estimated as Normalized Difference Vegetation Index (NDVI) with birth weight and term low birth weight (an increase in birth weight with increasing NDVI). Furthermore, we observed statistically significant associations for PM2.5, and built environment exposures such as walkability index, number length of public bus lines, number of facilities, presence of green space, connectivity density, building density, and land use Shannon's Evenness index and (low) birth weight, but mostly in our ExWAS analyses (after p value correction) and in general the results were not statistically significant when several exposures were included in the same model. Conclusion: This is the first large urban exposome study on birth weight testing many environmental urban exposures. It confirmed some previously reported associations e.g. for NDVI. We generated hypotheses for a number of built environment exposures.

## **001.04.18. Early Life Metal Exposures and Neurodevelopmental Trajectory Profiles: Assessment Using Parallel Latent Growth Mixture Models**

Shelley Liu

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**Abstract:** Introduction: Neurodevelopment delay is an important public health problem, affecting up to 15% of children. We aim to identify environmental risk factors that predict delayed trajectories of neurodevelopment using latent growth mixture modeling (LGMM). Methods: We use the Programming Research in Obesity, Growth, Environment and Social Stress, (PROGRESS) a longitudinal birth cohort in Mexico with repeated measures of Bayley Scales of Infant and Toddler Development (BSID) (n = 520). The BSID subscales for motor, cognition and language are assessed at four time points from 6 months to 24 months of age. Covariates include maternal hemoglobin, maternal IQ, socioeconomic status, maternal education level, child birthweight and child gender. We build parallel process LGMM to identify distinct subgroups (classes) with similar growth trajectories. We simultaneously model all three BSID subscales while adjusting for covariates, and allow for potentially nonlinear trajectories using quadratic growth factors. We then test for the association between blood metal concentrations (arsenic, cadmium, cobalt, chromium, cesium, copper, manganese, lead, antimony, selenium, zinc) collected during pregnancy and latent class membership. Results: We find that a four-class model best fits the data, and each class is characterized by distinct growth trajectories for the three BSID subscales. We interpret the classes as: high normal (4.2%), early normal (52.3%), late normal (35.2%), and early delayed (8.3%). The early delayed group has significantly lower exposures to zinc (p=0.05) at the second trimester of pregnancy, as compared with all other classes. Furthermore, the early delayed group has significantly lower concentrations of manganese (p=0.02), zinc (p=0.004) and copper (p=0.02) in child's blood at birth as compared with all other classes. Conclusions: Latent classes of neurodevelopment may be differentially vulnerable to metal exposures.

## **O01.04.19. A Causal Inference Approach to Understand the Link between Air Pollution Exposure and the Occurrence of Multiple Sclerosis Relapses**

Alice Sommer

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Abstract: When answering environmental health related questions, most often, only non-randomized observational data can be collected for ethical or practical reasons. The lack of randomized exposure prevents the identification of the causal effects on health outcomes. This barrier led the environmental epidemiology field to mainly consider associational models to examine relationships between environmental exposures and health outcomes. However, we believe that epidemiological researches should focus on the estimation of causal effects of plausible hypothetical interventions (e.g., reducing PM10) and suggest preventive environmental actions. Some statistical matching techniques exist to reconstruct plausible randomized experiments, which are the "gold standard" to establish causality. Based on an environmental epidemiology example, we will present, 1) how the conceptual and design stages can be performed prior to statistical estimation of causal effects, and 2) why this conceptual and computational work is relevant for making policy recommendations. A case-cross over study by Jeanjean et al. 2017 reported significant associations between multiple sclerosis (MS) relapse incidence and exposures to NO<sub>2</sub>, PM<sub>10</sub>, and O<sub>3</sub>. With the same data, we will show how constructing hypothetical experiments, thereby creating comparable groups of MS patients can provide results that are relevant for policy makers. Several epidemiological studies have reported significant associations between air pollution and multiple sclerosis (Oikonen et al. 2003, Gregory et al. 2008, Heydarpour et al. 2014, Angelici et al. 2016, Jeanjean et al. 2017), whereas other studies did not find any (Palacios et al. 2017). These conflicted findings demonstrate the gap of knowledge in understanding the causal air pollution-MS relationship. Our objective is to show that carefully avoiding confounding of the exposure assignment prior to any analysis can help to examine whether observed associations are truly causal.

## O01.04E. Prenatal Metals Exposure

### O01.04.20. Prenatal Heavy Metal Exposure and Newborn Leucocyte Telomere Length: A Birth-Cohort Study in Myanmar

Kyi Wai

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**Abstract:** Background: Arsenic, cadmium and lead are associated with telomere length (TL) maintenance in adults. Although they are confirmed to have trans-placental circulation, the effect of prenatal exposure of those metals on newborn TL is unknown. Objectives: The aim of this study was to determine whether prenatal heavy metal exposure has an impact on newborn leucocyte TL. Methods: A birth-cohort study was conducted with 409 pregnant women and their newborns in Myanmar. During the first visit, face to face interviews were performed and maternal spot urine samples were collected. Cord blood samples were collected during follow-up. Urinary heavy metal concentration was measured by ICP-MS and adjusted for creatinine. Relative TL was measured by quantitative real-time polymerase chain reaction. The extent of prenatal arsenic, cadmium and lead exposure and their associations with newborn leucocyte TL were assessed using multivariate linear regression. Results: The median values of maternal urinary arsenic, cadmium, and lead concentrations were 73.8, 0.9, and 1.8  $\mu\text{g/g}$  creatinine, respectively. Prenatal arsenic and cadmium exposure was significantly associated with newborn TL shortening (coefficient = - 0.13, 95% CI: - 0.22, - 0.03,  $p = 0.002$ , and coefficient = - 0.17, 95% CI: - 0.27, - 0.07,  $p = 0.001$ , respectively), and the associations remained robust after adjusting for confounders. However, there was no significant association between prenatal lead exposure and newborn TL. Conclusion: The present study identified the effect of arsenic and cadmium exposure on TL shortening, even in utero exposure at a lower concentration.

## **001.04.21. In Utero and Peripubertal Metals Exposure in Relation to Reproductive Hormones and Sexual Maturation in Girls**

Pahriya Ashrap

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**Abstract:** Metals occur naturally in the environment and are potential endocrine disrupting chemicals (EDCs). In utero development and adolescence are critical windows of susceptibility to EDC exposure. Few human studies have evaluated the impact of metal exposure on pubertal development. Our aim was to investigate in utero and peripubertal metal exposure in relation to pubertal development among girls from the Early Life Exposure in Mexico to Environmental Toxicants (ELEMENT) study. We measured urinary concentrations of Ni, Cu, Mo, Sb, Ba, Pb, Fe, As, Se, Al, Mn, Co, Zn, and Cd in maternal samples collected during the third trimester of pregnancy and their female children at 8-13 years (n=114). In girls, we measured serum testosterone, estradiol, dehydroepiandrosterone sulfate (DHEA-S), inhibin B, and sex hormone-binding globulin (SHBG) at age 8-13, and assessed sexual maturation (Tanner staging: breast, pubic hair development; menarche status), at two time points (8-13, 14-20 years). We used linear regression to independently examine in utero and peripubertal metal levels as predictors of peripubertal hormones. In a longitudinal analysis using generalized estimation equations, we evaluated Tanner stage and menarche progression in relation to in utero and peripubertal metal levels. We found that higher in utero Zn was associated with increased inhibin B, while in utero Ni, Al, Mn, and Cd were associated with slower progression of breast development after adjustment for child age and BMI z-score. Several metals at 8-13 years were associated with higher DHEA-S and estrogen, while Ni was positively but Cu was negatively associated with testosterone. Peripubertal levels of some metals were also associated with being at a higher pubic hair Tanner stage and menarche. These findings suggest that female reproductive development may be vulnerable to the effects of metal exposure, and using both Tanner stage and hormone levels provides essential information about underlying mechanisms.

## **001.04.22. Chemical Mixture Exposures during Pregnancy and Birth Outcomes**

Geetika Kalloo

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Abstract: Exposure to environmental chemical mixtures, which is prevalent among pregnant women, may be associated with altered fetal growth and gestational duration. In a prospective cohort of 380 pregnant women from Cincinnati, OH (enrolled 2003-2006), we quantified biomarker concentrations in urine and blood of 35 organic pollutants, cotinine, and 4 metals. We used K-means clustering and non-negative principal component (PC) analysis to characterize chemical mixtures among pregnant women. Then, we used multivariable linear regression to estimate and compare the covariate-adjusted associations of cluster membership or PC scores with gestational-age-specific birth weight z-score, birth length, head circumference, and gestational duration. Geometric mean biomarker concentrations were generally higher among women in cluster 1, intermediate among women in cluster 2, and lowest among women in cluster 3. Chemical biomarkers in the same structural or commercial family loaded onto the same PC. Compared with children born to women in cluster 3, children born to women in clusters 1 and 2 had 0.28 cm (95% CI: -0.86, 0.30) and 0.13 cm (95% CI: -0.65, 0.38) shorter birth length, respectively. Each standard deviation increase in PC 4 (correlated with organochlorine pesticides, cadmium, and lead) and PC 6 (correlated with mercury and monoethyl phthalate (MEP)) was associated with a 0.24 cm (95% CI: -0.49, 0.02) and 0.14 cm (95% CI: -0.42, 0.14) decrease in birth length, respectively. Chemical biomarkers with higher concentrations among women in clusters 1 and 2 loaded more strongly on both PC 4 and PC 6 than other PCs. Neither cluster membership nor PC scores were associated with birth weight z-score, head circumference, or gestational duration. In this cohort, cluster membership and PC scores reflecting exposure to cadmium, mercury, lead, organochlorine pesticides, and MEP were both inversely associated with birth length, but not other fetal growth measures or gestational duration.

## **001.04.23. The Relationships between Maternal Urinary Trace Metals and Plasma Immune Biomarkers during Pregnancy**

Tun (Max) Aung

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**Abstract:** Background: Environmental exposure to metals is widespread and may pose a risk for adverse birth outcomes. Metals may impact these outcomes through immunotoxic mechanisms via perturbations in maternal immune signaling molecules. We aimed to characterize associations between maternal urinary trace metals and plasma C-reactive protein (CRP) and cytokines in pregnancy. Methods: We conducted a cross-sectional study of pregnant women recruited early in pregnancy (<15 weeks gestation) from the LIFECODES birth cohort, which included 99 cases of preterm birth and 291 unmatched randomly selected controls. Through collaboration with the Children's Health Exposure Analysis Resource, we measured 17 urinary metals and five plasma immune biomarkers from samples collected in the 3rd trimester (median 26 weeks gestation). We used linear regression to calculate associations between metals and immune biomarkers, using inverse probability weights to account for case status, and adjusting for specific gravity, maternal age, race, and body mass index at the initial study visit. We used the elastic net to perform variable selection to assess relationships between multiple metals and immune biomarkers. Results: Single pollutant linear regression models revealed that several metals were associated with pro-inflammatory markers. An interquartile range (IQR) difference in Selenium (39 µg/L) was associated with a 65% increase in CRP (95% Confidence Interval (CI): 22.3 - 123). The elastic net revealed that Barium (Ba), Manganese (Mn), and Nickel (Ni) were positively associated with interleukin-1β (IL-1β), with Mn having the largest effect estimate. An IQR difference in Mn (0.6 µg/L) was associated with a 29% increase in IL-1β (95% CI: 12.4 - 48.2). Conclusions: Our results indicate that higher concentrations of Se, Mn, Ba, and Ni are related to higher pro-inflammatory immune biomarkers in pregnancy. Systemic immune perturbations may increase the risk of adverse birth outcomes.

#### **001.04.24. Bone Remodeling and Metals Exposure during Pregnancy: Results from Progress Cohort**

Citlalli Osorio-Yáñez

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**Abstract:** Background: Environmental exposure to metals has been associated with decreased bone density and higher risk of fracture mainly among premenopausal women and older adults. Metals such as lead (Pb) and cadmium (Cd) interfere with calcium incorporation into the bone cells leading to low bone density. However, little is known about the effects of metals exposure on bone remodeling during pregnancy, a window of susceptibility to the toxic effects of metals. Objective: The aim of this study was to assess concurrent exposure to metals [Pb, Cd, chromium (Cr) and arsenic (As)] and bone remodeling at radius during second and third trimester of pregnancy. Methods: We studied 1,054 mothers from PROGRESS cohort (Programming Research in Obesity, Growth, Environment and Social Stress). We measured BMD at radius by ultrasound and metals exposure by inductively coupled plasma during second and third trimesters of pregnancy. We generated linear mixed models to assess associations between metals exposure and z-scores at radius during second and third trimesters of pregnancy. Additionally, at each trimester of pregnancy, we assessed associations between metals exposures and z-scores using simple linear regression models. Results: At third trimester of pregnancy, Pb and Cr were associated with lower z-score at radius [for Pb (estimate: -0.89; 95% CI: -1.54, -0.24) and for Cr (estimate:-0.70; 95% CI: -1.37, -0.34)] in adjusted models. Similarly, we observed a decreasing trend in z-score at radius associated with Pb and Cr exposure during pregnancy, although it was not statistically significant. Overall, we did not observe associations between Cd or As and z-scores during pregnancy. Conclusions: Lead and chromium exposure during the third trimester of pregnancy might decrease bone remodeling at radius. Further studies should be conducted to assess bone remodeling at different anatomic sites in relation to metals exposure during pregnancy.

## Neurological and Cognitive Outcomes Associated with Air Pollution

### O01.04.25. Genetic Variation in Biotransformation Enzymes, Air Pollution Exposures, and Risk of Spina Bifida

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Abstract: Spina bifida is a birth defect characterized by incomplete closure of the embryonic neural tube. Genetic factors as well as environmental factors have been observed to influence risks for spina bifida. Few studies have investigated possible gene-environment interactions that could contribute to spina bifida risk. The aim of this study is to examine the interaction between gene variants in biotransformation enzyme pathways and ambient air pollution exposures and risk of spina bifida. We evaluated the role of air pollution exposure during pregnancy and gene variants of biotransformation enzymes from bloodspots and buccal cells in a California population-based case-control (86 cases of spina bifida and 208 nonmalformed controls) study. We considered race/ethnicity and folic acid vitamin use as potential effect modifiers and adjusted for those factors and smoking. We observed gene-environment interactions between each of the five pollutants and several gene variants: NO (ABCC2), NO<sub>2</sub> (ABCC2, SLC01B1), PM<sub>10</sub> (ABCC2, CYP1A1, CYP2B6, CYP2C19, CYP2D6, NAT2, SLC01B1, SLC01B3), PM<sub>2.5</sub> (CYP1A1 and CYP1A2). These analyses show positive interactions between air pollution exposure during early pregnancy and gene variants associated with metabolizing enzymes. These exploratory results suggest that some individuals based on their genetic background may be more susceptible to the adverse effects of pollution.

#### **O01.04.26. Fine Particulate Matter Air Pollution and Incidence of Cognitive Impairment among the Elderly in China**

Jiaonan Wang

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**Abstract:** Background/Aim: Long-term exposure to fine particulate matter (PM2.5) has been shown to increase risk of cognitive impairment. However, research on the relationship between exposure to PM2.5 and cognitive function is lacking in developing countries, especially in highly polluted areas. The aim of this study is to determine if exposure to PM2.5 is associated with cognitive function in a diverse, national sample of older adults in China. Methods: This analysis included data on 5704 older adults aged  $\geq 65$  years from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) in 2008-2011, which randomly selects half of the counties and cities in 23 of China's 31 provinces. We used geographic information system to estimate annual average satellite-derived PM2.5 concentration for the geocoded location of participants' baseline residences enrolled between 2008 and 2011. The cognitive function was assessed with Mini Mental State Evaluation (MMSE) scale. Association between PM2.5 concentration and cognitive impairment was analyzed by logistic regression model. Results: The average age of participants was 79.6 years. Logistic regression analysis results showed that a  $10\mu\text{g}/\text{m}^3$  increase in PM2.5 concentration was associated with an increased odds of incident impairment, after adjusting for demographic factors and behavioral factors [RR (95% CI): 1.06 (1.01, 1.11)]. The effect is especially significant in men, current alcohol drinker, current smoker, the elder age group and hypertensive patients. Conclusions: PM2.5 was associated with increased risk of cognitive impairment incidence in the elderly of China. Air pollution reduction is a potential measure for reducing the future population burden of age-related cognitive decline, especially in heavy air polluted area.

## S01.04A. Addressing Complexities through Partnership and Collaboration in the Arctic

### **S01.04.01. Exposure to Perfluoroalkyl Substances and Polybrominated Diphenyl Ethers from Traditionally Harvested Food Animals on St. Lawrence Island, Alaska**

Sam Byrne

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**Abstract:** The Arctic serves as a hemispheric sink for persistent organic pollutants (POPs). Indigenous arctic populations are exposed to POPs through traditional harvest of food animals, including marine mammals. This study quantified 13 perfluoroalkyl substances (PFAS) and 40 polybrominated diphenyl ethers in traditional food animals harvested by residents of St. Lawrence Island, Alaska. Of 13 measured PFAS, 9 were detectable in any sample. Overall PFAS concentrations were highest in seal tissue. In seal tissue samples, Perfluoropentanoic acid (PFPeA) was the most commonly detected PFAS, and was present at the highest mean concentration of any PFAS (15.4 ng/g ww). PFPeA was also the most commonly detected PFAS and was present the highest maximum concentration (24.8 ng/g in seal muscle). Analysis of heart, liver, kidney and intestine samples from a single juvenile seal suggest that PFAS may preferentially partition into organs. Both total concentrations of PFAS and the number of detectable compounds were higher in these organ meats. Polybrominated diphenyl ethers (PBDEs) were detected in 100% of traditional foods samples. BDE-47, 99, 100 and 209 tended to make up a large percentage of overall PBDE concentrations. Seals had the highest median concentrations compared to other species. BDE-47 made up the majority of overall PBDE concentrations in seal samples. The median total PBDE concentration in seal blubber from this study (2,511 pg/g ww) was lower than the concentration reported in harbor seals collected in Alaska in 2000-2002 (14,600 pg/g ww). This is consistent with the overall decreasing trends of PBDEs in the Arctic.

## **S01.04.02. Overview of Human Health Risk Assessments**

Zoe Gillespie

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Abstract: A general overview of the role of Health Canada's Food Directorate within the Northern Contaminants Program and how country food contaminant data is assessed in order to provide a health risk opinion. This overview will include a hypothetical case study to illustrate the various factors and the uncertainties that are considered with an assessment and highlight additional factors that are taken into consideration when determining whether consumption advisory is warranted.

### **S01.04.03. Discovering Chemicals of Emerging Arctic Concern: Application of New Analytical Approaches to Human Biomonitoring**

Pierre Ayotte

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Abstract: Different analytical strategies are used to discover chemicals of emerging concern in the Arctic. While traditional targeted analyses allow for the identification and quantification of chemicals with a priori knowledge of their presence, semi-targeted and untargeted analyses also permit samples obtained in the framework of human biomonitoring studies to be screened for the presence of unknown or unsuspected pollutants. We recently applied these different analytical strategies to human biomonitoring studies conducted in various regions of the Arctic. Chemical families targeted in plasma samples include polychlorinated biphenyls and chlorinated pesticides, polychlorinated dibenzo-p-dioxins and dibenzofurans as well as perfluorinated compounds. Targeted interrogation of the non polar purified extracts revealed the presence of chlorobenzenes, polycyclic aromatic hydrocarbons, polychlorinated naphthalenes, polychlorinated terphenylenes, short-chain chlorinated paraffins and natural halogenated compounds. Through untargeted analyses of extracts, thousands of entities are detected. Chemometric methods such as Kendrick mass defect plot and isotopic pattern detection can be used to attribute unknowns to the proper chemical family and facilitate compound identification. These innovative strategies will help identifying chemicals of emerging Arctic concern that should be included in future biomonitoring studies and considered for inclusion under the Stockholm Convention.

#### **S01.04.04. Human Health in the Arctic: The Arctic Monitoring and Assessment Programme**

Jon Oyvind Odland

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Abstract: The Arctic Monitoring and Assessment Programme (AMAP) has a history back to 1991. The Human Health Assessment Group (HHAG) was established in 1993. The first report was submitted in 1998, followed by comprehensive reports in 2003, 2009, and 2015. The generous contribution from the Canadian partners in the first phase resulted in a historical monitoring program with samples from all Arctic countries analysed at CTQ in Quebec, with strict routines of sampling, storage, transportation, and finally analyses of toxic and essential metals, as well as persistent toxic substances (PTS) in blood samples from all participating countries. The first report was mostly a monitoring of levels in human samples, while the following reports built on the mother-child cohorts connected to the monitoring, with continuous new knowledge of human health effects in the complicated field of child development, nutrition, life style, and exposure to the toxic elements. The cohorts are ongoing, and the communication of results is steadily developed in close collaboration with health authorities. This presentation will present the broad picture, but also discuss recent important findings, effects in different geographical areas, and give future perspectives for public health impact from contaminants, nutrition, and life style. The development and sustainability of the partnership in the group is crucial for future work on both monitoring and effect studies. The group has also added new knowledge to global environmental science, with specific strategies for cohort studies in scarcely populated regions.

## S01.04B. Aggregate Exposure and Cumulative Risk Assessments in the Euromix Project

### S01.04.06. Identification of Key Mixtures in European Countries and Assessment of Consequential Exposures

Amélie Crépet

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Abstract: Through their diet, populations are exposed to mixtures of chemicals which can cause health diseases. Due to the complexity of mixtures, the question of which substances should be assessed together remains a big challenge. The EuroMix project developed a strategy for mixture risk assessment and proposed an original method combining exposure and hazard information to identify the key mixtures of chemicals to which populations are exposed. The principle is to reduce the number of substances in a defined cumulative assessment group (CAG) identifying co-occurring substances in diet. The method is based on sparse non-negative matrix under approximation to factorize the co-exposure matrix into two non-negative matrices. The method is illustrated on the liver steatosis CAG using children and adults exposure in 9 European countries. Food consumption and pesticide residue in food and drinking water came from national surveys. Exposures of 144 pesticides were evaluated through scenarios related to chronic/acute exposure and merged/country specific residue data. Relative potency factors were calculated to express the potency of each substance relative to the flusilazole and multiplied by the exposure. Considering chronic exposure, one mixture explained the major part of the total variance for each country, while in acute exposure, several mixtures were often needed to explain the major part of the total variance. The results showed that 15 pesticides were mainly observed in mixtures, with a high contribution of imazalil and dithiocarbamates. The originality of the proposed approach was to start from a CAG and to integrate information from co-exposures to identify key mixtures with much fewer components. As this approach was sensitive to the input data heterogeneity, efforts should continue on data collection and harmonization among the different aspects within the regulatory framework.

#### **S01.04.07. Verification of Aggregated Exposure to Bisphenols from Diet and Cosmetics - The Human Biomonitoring Study from the EU Project Euromix**

Monica Andreassen

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Abstract: Bisphenols have many applications in consumer products, and exposure occurs from a vast number of sources and via several routes. In order to examine the plausibility of source-to-dose calculations of aggregate exposure of bisphenols in the EuroMix project, a biomonitoring study was performed. For two 24-hour study periods separated by 2-3 weeks, adult volunteers (n=144) in Norway kept detailed diaries on food consumption (type/brand of foods, weight, time point and packaging material) and the usage of PCPs (type/brand of product, time and number of applications, and number of showers and hand washes). Concurrently, 24h urine was collected and urinary levels of the bisphenols BPA, BPS, BPF, and BPAF were analyzed using on-line column switching ultra high performance liquid chromatography and tandem mass spectrometry (UPLC-MS-MS). The exposure models MCRA and PACEM were used to estimate dietary and non-dietary exposure of the bisphenols in line with the information obtained from the study. Bisphenol concentrations in food and PCPs were taken from literature. Internal exposures were obtained with a previously published PBPK model. Estimates of voided urine concentrations obtained with the models were then compared with measured urine concentrations to evaluate the coupling of aggregate exposure models, which was developed within the EuroMix framework.

#### **S01.04.08. Aggregate and Cumulative Exposure to Pyrethroids of French Population**

Marie Vanacker

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Abstract: Pyrethroids are commonly used as insecticides and can be found in both outdoor and indoor environments. More specifically, these substances could be found in food, in air, in dust, in cosmetics and in veterinary products. The ENNS study (2005-2006) showed that the pyrethroid metabolite body burden of the French adult population is much greater than German and North-American ones. In response to this observation, aggregate and cumulative external exposures of the French adult population to four major pyrethroids (cyfluthrin, cypermethrin, deltamethrin and permethrin) were evaluated, taking into account exposure by ingestion, inhalation and dermal contact. In total seven routes of dietary and non-dietary exposures were combined (food ingestion, dust ingestion, dust dermal contact, air inhalation, dermal contact by animals and by cosmetics). For left censored data, two scenarios using lower (LB) and upper bounds (UB) were compared. Exposure sources contributing the most to aggregate exposure were then identified for each substance and censor scenario. The cumulative risk assessment associated to the neurotoxicity effect was also evaluated using relative potency factors based on deltamethrin, as the substance of reference. First results showed that the sources of exposures and the contribution of substances mainly differed between the different censor scenarios. The dietary exposures of deltamethrin and cypermethrin, and the dermal contact exposure of permethrin through animal handling, were the main contributors of the cumulative exposure for the LB scenario, while the dietary exposure of cyfluthrin and the deltamethrin contributed the most for the UB scenario. These results confirm high values of metabolites in the French adult population. After integrating the external exposure in a PBPK model, the resulting metabolite body burden will be compared to those observed in the ENNS study.

#### **S01.04.09. Aggregate Exposure and Cumulative Risk Assessment of the Bisphenols BPA, BPS, BPF, and BPAF for the French Population**

Cecile Karrer

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Abstract: Bisphenol A (BPA) is used in the production of polycarbonate plastics and epoxy resins and for the color development in thermal paper (TP). In the EU, since 2011 its use in plastic materials and articles intended to come into contact with food is subject to a migration limit. In view of the increasingly strict legislation, industry has partly turned towards replacement chemicals for BPA, such as bisphenol S (BPS), bisphenol F (BPF), and bisphenol AF (BPAF). These analogues can e.g. be found in foodstuffs, indoor dust, and thermal paper. Several studies showed that they exert estrogenic effects just like BPA. To evaluate whether the European BPA restrictions had effects on exposures to BPA and its analogues, we conducted comparative exposure and risk assessments for the time before and after the year 2011. We modeled exposures for European consumers and further focused on the French population. We regarded all sources, which significantly contributed to exposure in previous assessments: dietary and dust ingestion, and dermal exposure from personal care products (PCPs) and TP. Wherever possible, we used concentration data from before and after 2011, respectively. We used the Monte Carlo Risk Assessment (MCRA) model for dietary exposure, the Probabilistic Aggregate Consumer Exposure Model (PACEM) for exposure to PCPs and other probabilistic models for TP and dust. We aggregated the realistic external exposures from different sources by means of a physiologically based pharmacokinetic (PBPK) model developed previously for these bisphenol analogues, yielding internal exposures. We used relative potency factors to estimate the cumulative risk that could result from combined internal exposure to BPA, BPS, BPF, and BPAF. For this, we compared the margins between effective concentrations and the cumulative internal exposures for the time before and after 2011.

## **S01.04.10. Taking Account of Variability and Uncertainty in Cumulative Risk Assessment**

Waldo de Boer

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Abstract: Human populations are exposed to many chemicals that may cause the same health effect. In a risk assessment, exposures coming from dietary and non-dietary routes (e.g. oral, dermal and inhalation) are aggregated and combined with hazard data. The aim is to characterise the health impact due to the combined effect of multiple chemicals. In a refined approach, kinetic models translate the external dose coming from various routes to the internal dose at the level of the target organ, e.g. the liver. The models are substance-specific, so accumulation over multiple substances can only be performed at the internal dose level. Humans may be exposed to hundreds or thousands of chemicals that may cause the same health effect, facing kinetic modellers with a seemingly impossible task. So there is a need for model simplification or simple approaches like using absorption factors to obtain generalised models for classes of substances. The EuroMix toolbox is a user-friendly, web-based platform that implements models for exposure and risk assessment. Both exposure assessment through the use of kinetic models and hazard characterization are included in a probabilistic way. Uncertainties involved enter the model by using a two dimensional Monte Carlo approach. This results in an uncertainty distribution for any statistic of interest, e.g. the margin of exposure.

## S01.04C. Assessing Health and Well-Being Benefits of Exposure to Natural Environments: Methodological Challenges and Opportunities

### S01.04.11. Urban Green Spaces and Health - Evidence, Limitations, and Ways Forward

Matilda van den Bosch

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**Abstract:** Based on scientific evidence, the World Health Organization advocates for public green space as an important component of healthy cities. Different pathways and mechanisms are likely to mediate the health effects of exposure to green spaces. Those range from stress reduction and increased physical activity to regulating ecosystem services, such as heat and noise reduction. Many of these pathways are causally related to common non-communicable diseases, for example, depression, and urban heat related morbidity, disorders that have been negatively associated with exposure to green spaces. The evidence is limited by various factors, such as lack of validation of exposure metrics and shortness of experimental data. Attempts to standardise and optimise exposure metrics are ongoing, but depending on what health outcome is studied different types of measurements are needed. For example, measuring the impact on heat related morbidity may require different metrics than for estimating mental health benefits. Aspects of green space exposure to be considered for measurement are availability, accessibility, qualities, and usage. Availability and accessibility can be determined for large-scale population studies and are often assessed through remote sensing data of various spatial resolution, sometimes combined with other data sources for mapping of land cover types, such as different tree species, of land use, such as recreational areas and sport facilities. Evaluating qualities of green spaces often requires field studies or qualitative analyses, resulting in smaller scale studies. Usage of natural spaces can be identified by big data collection, from sources such as accelerometers or smart phone applications. This presentation will provide an overview of the evidence on associations between urban green spaces and health, based on a systematic review of the literature. It will critically discuss existing exposure metrics and potential for validation and development.

## **S01.04.12. Does Physical Activity Mediate the Effect of Residential Greenness on Mental Health and Subjective Well-Being? Findings from the Sister Study**

Raquel Silva

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**Abstract:** Although a growing body of research shows that exposure to natural environments benefits physical and mental health and well-being, there remain significant gaps in our understanding of the factors that influence the association between exposure and health and well-being outcomes. Addressing these gaps, we present results from two projects using health data from NIEHS' Sister Study and residential greenness derived from the US National Land Cover Database. The Sister Study collects various measures from over 50,000 women aged 35-74 years across the United States. The cohort covers broad geographic distribution and demographics that help us understand the potential mechanisms between exposures to nature and health outcomes. Previous cross-sectional analyses of the Sister Study by Villeneuve and colleagues found reduced risks of obesity (body mass index  $\geq 30$ ) for women who lived in areas with the highest tertile of greenness within a 500m residential buffer (odds ratio (OR) = 0.83, 95% CI = 0.79-0.87) relative to those in the lowest tertile. Further, mediation analyses showed that physical activity attenuated the association between greenness and obesity by 32%. In this presentation, we analyze the associations between residential greenness within 250m, 500m, and 1250m buffers, and self-reported health, perceived stress, depressive symptoms and quality of life, controlling for sociodemographic factors, lifestyle, and environmental stressors. Then, we discuss how levels of physical activity mediate the association between mental health and residential greenness. Additionally, we extend previous analyses that investigated the association between overall physical activity and nearby greenness to examine associations with specific types of recreational physical activities, particularly those more likely influenced by proximal greenness. Finally, we discuss the impact of using different metrics for exposure assessment and propose future directions for this research.

### **S01.04.13. High-Resolution Measures of Natural Environments and Mental Health Outcomes in the Nurses' Health Studies**

Peter James

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**Abstract:** The biophilia hypothesis and psychoevolutionary theory suggest that exposure to nature might be linked to better mental health outcomes. Recent studies have observed associations between exposure to nature and mental health; however, many of these studies have used coarse vegetation indices to assess exposure to nature. In addition, as far as the authors are aware, no prior study has examined the relationship between nature and positive psychological constructs, such as optimism. Using high-resolution, aerial photography-based data on natural environments from EPA EnviroAtlas datasets across 18 urban areas, we examined the relationship between residential exposure to natural environments (including green space, tree cover, and proximity to parks) and validated self-reported measures of doctor-diagnosed depression, depressive symptoms, doctor-diagnosed anxiety, social integration, and optimism in over 12,000 female participants in the Nurses' Health Study and Nurses' Health Study II cohorts located in communities across the entire United States. Analyses were adjusted for age, race educational attainment of each participant and her husband, smoking, alcohol consumption, alterative healthy eating index, BMI, and census-tract median family income, home value, and population density. We tested effect modification by individual and area-level socioeconomic status (SES), race, physical activity, population density, and region. Using extremely high-resolution data on natural environments, this study will build the evidence base for nearby nature as a potential environmental intervention to improve psychological well-being. Municipalities have engaged in tree planting and other landscape interventions as part of climate change mitigation and adaptation efforts, and this study provides vital data on nature as a co-benefit for mental health.

#### **S01.04.14. Living Close to Water Is Associated with Reduced Risks of Mortality in Canada's Largest Cities: Results from the Canadian Census Health and Environment Cohort**

Dan Crouse

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Abstract: Increasing evidence suggests that residential exposures to natural environments, such as green space, are associated with many health benefits. Only a single study has examined the potential link between living near water and mortality. Here, we examine whether living near large, natural water features (e.g., lakes, rivers, coasts, "blue space") is associated with decreased risk of dying from cause-specific mortality among urban, Canadian adults, controlling for many individual and contextual covariates, along with exposures to ambient air pollution and residential greenness. Specifically, we examined whether living within 250 m of blue space was associated with cause-specific mortality among adults living in the 30 largest Canadian cities drawn from the 2001 Canadian Census Health and Environment Cohort. Our cohort included ~1.3 million subjects at baseline, 106,180 of whom died from non-accidental causes during the 11 years of follow-up. We found significant, reduced risks of mortality in the range of 12-17% associated with living within 250 m of water compared to living further away, among all causes of death examined, except with external/accidental causes. For example, in fully-adjusted models, the hazard ratio for non-accidental deaths was 0.879; 95% confidence intervals: 0.861-0.897. Effects were more protective among women and older adults, and most protective for deaths from stroke and respiratory-related causes. Our findings suggest that everyday residential exposures associated with living near blue space in urban areas have important benefits to health, which may be different from those achieved through purposeful visits to natural areas, such as parks or beaches. The findings here suggest that exposures to blue spaces in particular may have much stronger benefits to health than previously suggested.

S01.04D. Biomonitoring Data from the Canadian Health Measures Survey in Risk Assessment: A Decade of Progress

**S01.04.16. Making Biomonitoring and Exposure Knowledge More Accessible for Risk Assessment**

Annie St-Amand

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Abstract: Health Canada has invested over the decade at research for the interpretation of Canadian Health Measures Surveys (CHMS) with Biomonitoring Equivalents. The continued collaboration with scientists and regulators from various branches has matured from feasibility research studies into a priority and screening tool that is scientifically sound for chemical assessment at Health Canada. The presentation highlights the success of exposure sciences research implemented into policy for regulatory purpose. After being supported by Chemical Management Plan Monitoring and Surveillance, Biomonitoring Equivalent (BE) research has provided a simple way to understand the health risks from levels measured in biomonitoring surveys. A BE is a screening tool that translates guidance exposure values into an internal metrics or biomarker levels which can be compared to results of biomonitoring surveys. Initially, the study investigated the feasibility of BEs for the interpretation of Canadian Health Measures Survey. The work then continued with BE method development for Health Canada chemical evaluations, capacity building and knowledge transfer. Now, BE are currently being used for screening of biomonitoring data for Chemical Management Plan chemicals at Health Canada. With several publications and policy documents, BEs are helping to identify substances that are of low concern to human health at current levels of exposure under the Chemical Management Plan. The continued collaboration with scientists and regulators from various branches has enabled this research to mature into a robust tool that is scientifically sound for chemical risk assessment and management.

#### **S01.04.17. Using Biomonitoring Data from the Canadian Health Measures Survey and Biomonitoring Equivalents to Assess Risk Associated with Essential Nutrients**

Kristin Macey

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*1. Health Canada, Ottawa, ON, Canada.*

Abstract: Health Canada conducts human health risk assessments for priority substances under the Chemicals Management Plan. Many of these are essential nutrients for human health, including selenium, molybdenum, iodine and zinc. However, elevated exposures can result in adverse health effects. Although the diet is the primary route of exposure to these nutrients, they are ubiquitous in environmental media and as such, there is also potential for exposure from air, water, soil, and house dust. In addition, these substances are present in thousands of products available to consumers; which contributes to overall exposure. With the availability of human biomonitoring data from the Canadian Health Measures Survey (CHMS), Health Canada was able to evaluate integrated exposure from all sources, as biomonitoring data can be used as a measure of internal exposure regardless of the source. General population biomonitoring data from the CHMS, coupled with biomonitoring equivalents (BEs), i.e., the blood or urine equivalent of an exposure guideline such as a tolerable daily intake or reference dose, provided evidence of safety for the general population for selenium, molybdenum, iodine and zinc. Comparison of the CHMS biomonitoring data with data from smaller target studies revealed subpopulations in Canada with elevated exposure and the potential for adverse health effects. Using the same approach, biomonitoring data coupled with BEs for nutritional adequacy (e.g., the estimated average requirement) can also be used to evaluate the nutritional status of Canadians. On average, Canadians meet dietary recommendations for these nutrients, although some deficiencies have been observed across the population.

#### **S01.04.18. Fluoride Levels in Urine and Tap Water in Canada: Data from the Canadian Health Measures Survey 2012-2015 and Interpretation in a Risk-Based Context**

Lesla Aylward

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**Abstract:** Fluoride is recognized as beneficial to dental health because of its ability to prevent tooth decay. However, excessive fluoride intake may cause dental fluorosis, and at much higher levels skeletal fluorosis and other adverse health effects. For many years, water fluoridation has been introduced in various Canadian communities and around the world as a public health measure to prevent dental decay. Besides tap water, Canadians are exposed to fluoride through food, beverages, and fluoridated dental products. In order to track fluoride exposure in Canada, fluoride levels in urine and tap water of Canadians have been monitored in the Canadian Health Measures Survey (CHMS) in 2012-2015. Using CHMS data and municipal fluoridation information, this study examined fluoride levels in urine and tap water of the Canadian population and potential associations between urinary fluoride levels and various exposure factors. It also aimed at interpreting the urinary fluoride levels in a risk-based context using biomonitoring equivalent (BE) values. Analysis showed that urinary fluoride levels varied by age and sex. Children aged 3-5 years had the highest urinary fluoride levels while the 11-19-year-old had the lowest concentrations. Females had higher urinary fluoride levels than males. The vast majority of Canadians had tap water fluoride levels lower than Health Canada's maximum acceptable concentration. The results also showed that the majority of the population had urinary fluoride levels below the BE values, suggesting that exposure levels in Canadians are generally below the recommended adequate intake levels for fluoride for the prevention of dental caries. This study presents the first nationally representative dataset on fluoride, which will be helpful to inform future risk assessment and management of this chemical in Canada.

#### **S01.04.19. Interpretation of Urinary Concentrations of Pyrethroid Metabolites in the Canadian Population in a Risk Context: Associated Factors and Comparison to Biomonitoring Equivalents**

Kim Irwin

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**Abstract:** Pyrethroids are extensively used in agricultural, commercial and residential pest control, and are implicated in adverse health outcomes in humans. We evaluated the associations between socio-demographic and dietary factors and urinary concentrations of pyrethroid metabolites in the Canadian general population using data collected under the Canadian Health Measures Survey (CHMS) cycles 1 and 2 (2007-11), and assessed the data in a risk context using the screening-level biomonitoring equivalents for 3-phenoxybenzoic acid (3-PBA), a common metabolite of several pyrethroids. Data from CHMS cycles 1 and 2 were combined for the analyses. Regression analysis revealed significant ( $p < 0.05$ ) age-dependent differences in the least-square geometric mean (LSGM) concentrations of the sum of all measured pyrethroid metabolites, or 3-PBA (LSGM for 20-39 years > 12-19 years). The concentrations were also associated with sex (females > males), country of birth (other than Canada > Canada), body mass index (normal weight > obese), season (fall > summer), use of home/yard pesticides or lice/flea control products (yes > no), and frequency of consumption of vegetables (high > low) and starchy roots (low > high). The geometric mean concentrations of 3-PBA for all age and sex groups from CHMS cycles 1 and 2 did not exceed the Tier 1 screening value of 1.7  $\mu\text{g/L}$  based on the most stringent of the biomonitoring equivalents derived for the chronic dietary RfD (USEPA) and ADI (WHO/FAO/EC) suggesting that the cumulative exposures to pyrethroids in Canadians are low relative to guidance values, and existence of a margin of safety. Additional data on pyrethroid metabolites in Canadians from CHMS cycle 5 (2016-17) and cycle 6 (2018-19) will support an assessment of trends in exposure and future evaluation of risks.

## **S01.04.20. Screening of Population Level Biomonitoring Data from the Canadian Health Measures Survey in a Risk Based Context**

Annie St-Amand

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Abstract: Canada's comprehensive and nationally-representative Canadian Health Measures Survey includes a biomonitoring component which has measured over 250 chemicals in approximately 29,000 Canadians over a ten-year period. Our capacity to interpret biomonitoring results in relation to the risks these levels pose to human health is gradually improving with the development of biomonitoring equivalents (BE) and human biomonitoring values (HBM values). Biomonitoring data from various cycles of the CHMS are compared with published BE values for chemicals with short half-lives, persistent chemicals, and volatile organic compounds (VOCs). Hazard quotients are calculated as the ratio of the biomarker concentration to the chemical-specific BE value using both the geometric mean (GM) and upper bound (95th percentile). Hazard quotients near or exceeding a value of 1 are indicative that exposure levels are near or exceeding the exposure guidance values on which BEs are based. For example, acrylamide is assessed by comparing levels of two of its metabolites in blood, namely AAVal and GAVal. Hazard quotients for AAVal exceed the BE at the 95th percentile for smokers. This exceedance is not seen in non-smokers. A similar pattern is observed for GAVal. Although more work will be needed to fully evaluate available Canadian human biomonitoring data against established guidance values, this screening exercise can help to prioritize risk management actions for some toxic chemicals and show the importance of continued biomonitoring to assess population exposures and exceedances.

## S01.04E. Clean Cooking Implementation Science to Understand Complex Determinants of Clean Fuel Technology Adoption

### **S01.04.21. Introduction: Implementation Science to Reduce Household Air Pollution (HAP) Exposures in Low and Middle-Income Countries (LMICs)**

Joshua Rosenthal

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**Abstract:** HAP exposures are responsible for a major proportion of the total disease burden in LMICs. To address this, the NIH led Clean Cooking Implementation Science Network (ISN) is developing methods to elucidate technologies, conditions, and implementation strategies that can result in the largest reductions in HAP exposures. The challenge is to accelerate widespread, sustained and nearly exclusive adoption of clean cooking to promote public health. In this symposium we present a brief introduction to the network and its approach, followed by study results from interventional and natural experiments in India and Sub-Saharan Africa. For example, India has recently launched an enormous effort to provide access to clean cooking fuels such as Liquefied Petroleum Gas (LPG) to nearly 50 million homes by 2019, but challenges of sustaining LPG use remain to be overcome. Implementation science has evolved precisely to meet this kind of complex, multidimensional problem. Finance, access to services, ambient air quality, climate, home construction, community structure, cultural traditions and gender are among the complex variables addressed in the network's research. The ISN projects presented here use a diversity of methods - including social network analysis, microfinance experimentation, novel survey methodologies and sensor-based monitoring of stove-use and resulting exposure levels - to understand the potential drivers of decision making in rural and peri-urban, low income settings. In this brief introduction to the research we provide background on the scope of the problem and an outline of the approaches we are taking to employ research that will accelerate the transition to clean cooking fuels around the world.

## **S01.04.22. Economic Experiments to Measure LPG Stove Demand and Impacts on Cooking Behaviors and Exposures in Northern Ghana**

Katherine Dickinson

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Abstract: The Prices, Peers, and Perceptions (P3) project in the Kassena-Nankana Districts (KND) of Northern Ghana is conducting field experiments to better understand factors influencing adoption and use of cleaner cooking technologies, and the contribution of cooking emissions to air quality and exposures in this region. In the urban areas of the KND, liquefied petroleum gas (LPG) stove-fuel packages are offered to randomly selected households using a one-on-one auction procedure. Our interdisciplinary study design and methods allow us to: 1) measure willingness to pay for different package components, such as the type of stove (one vs two burner), and fuel delivery method (home delivery vs at refilling station); 2) randomize distribution of these different packages to participants, at varying price levels; and 3) measure subsequent impacts on cooking behaviors (including use of LPG and traditional stoves), household air quality, and personal exposure to particulate matter.

## **S01.04.23. The Bottled Gas for Better Life Pilot: An Evaluation of the First Microfinance Initiative in Cameroon to Support Households Switch from Solid Fuel to LPG for Cooking**

Dan Pope

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**Abstract:** Introduction the LPG Adoption in Cameroon Evaluation (LACE) studies aimed to identify and address barriers to adoption and use of liquified petroleum gas (LPG) as a clean fuel. This included evaluation of a microfinance scheme (paid back over 6 months) to fund an LPG start-up kit (stove, equipment and gas; US\$95), a barrier to adoption identified by LACE. We report here impacts on fuel-use practices, household air pollution exposure, acute health symptoms and burns in loan beneficiaries. Methods 110 beneficiaries completed household surveys prior to receiving the LPG start-up kit, and then again after the loan period. Additional surveys were completed by 500 households each from beneficiary and control communities. 48-hr PM<sub>2.5</sub> samples (kitchen concentrations and cook exposures) were measured in 35 beneficiary households at the two data collection periods using the RTI MicroPEM. Results Most households repaid the loan (89%), although 41% reported difficulty making repayments. After the loan, primary fuel use changed from wood (75%) and other biomass (15%) to LPG (79%), although no households used LPG exclusively. Levels of PM<sub>2.5</sub> declined from baseline to after the loan period for kitchen concentrations (geometric mean (GM) 337.9 µg/m<sup>3</sup> vs 32.3 p<0.0005) and cook exposures (GM=73.8 µg/m<sup>3</sup> vs 28.6 p<0.0005). Significant reductions in headaches (46% to 9%; p<0.0005), eye problems (66% to 8%; p<0.0005), cook burns (25% to 3%; p<0.0005) and child burns (9% to 0%; p<0.0005) were observed after the loan. An increase in primary use of LPG was observed in the beneficiary community (46% to 55%) not seen in controls (67% to 67%). Conclusion Successes of this loan pilot included (i) a high level of repayment and LPG use, (ii) reductions in household air pollution, self-reported health symptoms and burns and (iv) increased community adoption of LPG. Fuel stacking remains an ongoing issue. The pilot has informed a second phase involving 800 homes across five regions of Cameroon.

#### **S01.04.24. Understanding Household, Network, and Organizational Drivers of Adoption, Sustained Use, and Maintenance of Clean Cooking Fuels in Rural India**

Gautam Yadama

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**Abstract:** To reduce household air pollution (HAP) the emphasis is now on transitioning households and communities to cleaner Liquefied Petroleum Gas (LPG) based cooking systems. The objective of our case-control study is to examine household, network, and organizational drivers that influence adoption and sustained use of LPG in Below Poverty Line (BPL) households in rural India. Our aims are: 1) understand how rural LPG adopters vary from other rural households on factors of affordability, accessibility, and awareness (3As) of LPG; 2) evaluate the relative influence of gender-based personal networks on LPG adoption in these rural households; and 3) determine how the 3As affect sustained use of LPG in adopter households. Our findings come from a multistage random sample in 35 habitations of rural Andhra Pradesh, India. Data for Aim 1 were collected through a set of semi-structured questionnaires administered to 510 households. For Aim 2 we used a standardized personal gender based network survey administered to 200 households. We are currently collecting data for Aim 3 by deploying stove use monitoring technologies to record cookstoves' usage patterns in real time for 65 households for one year. We will present our results for aim 1 and aim 2 from this ongoing study. Our findings show that 3As concurrently impact the adoption of LPG in poor rural households. Specifically, our results indicate the following factors are salient and have a positive effect on LPG adoption in rural India: 1) income of women; 2) income of households; 3) proximity to LPG distribution centers; 4) proximity to tarmac roads; 5) remoteness to freely available biomass from forests; and 6) awareness campaigns. Our findings also reveal the importance of structure and composition of personal gender-based networks in the uptake of LPG. Lessons from this study are timely, relevant, and of interest to Government of India's renewed emphasis on expanding LPG distribution to the poor in rural India.

#### **S01.04.25. Enhancing Usage of Clean Fuels among Pregnant Women in India**

Ajay Pillarisetti

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**Abstract:** Background. Recent Indian policies have vastly expanded access to clean fuels. Access does not necessarily lead to displacement of traditional stoves and fuels, however. We evaluated methods to encourage usage of LPG, including provision of subsidized and free fuel. We also explored recruiting women at marriage to cover the vulnerable time prior to typical detection of pregnancy. Methods. 150 pregnant women and 50 newly married couples were recruited through local accredited social healthcare activists (ASHAs). Participants were provided an LPG stove, related accessories, and two full LPG cylinders. Stove use monitors were installed on the primary traditional and stove and on both LPG burners. Households were asked to destroy or remove their traditional stoves upon receipt of the intervention package. Pregnancy arms included free fuel (n=50), fuel subsidized on usage (a conditional cash transfer or CCT, n=50), and a control arm (n=50). Newly married couples (n=50) were provided a stove and related accessories. PM exposures and kitchen concentrations were measured. Results. Over two-thirds of households either destroyed or removed their traditional stoves. The number of refills was much higher in the free fuel arm than in either the conditional cash transfer or control arms. Recruiting at marriage proved successful, with approximately 1/3 of households pregnant within 4 months of recruitment. Approximately 66% of households have purchased or will purchase their second LPG cylinder rather than return it to the study. Conclusions. Provision of free fuel during pregnancy fits well within Indian paradigms of providing services to poor households. Assuming detection in the third month of pregnancy, such a program would cost approximately 70 dollars per household for fuel. Expanding to newly married couples could cover vulnerable periods of pregnancy prior to typical detection. Providing a second cylinder appears valuable to households to smooth out supply issues.

## S01.04F. Climate, Air Pollution, and Environmental Health in Africa 2

### **S01.04.26. The Canaries in the Coal Mine of Climate Change Impacts: Understanding the Threats that Climate Change Poses to Respiratory Health of Workers**

Isabella Annesi-Maesano

*Isabella Annesi-Maesano<sup>1</sup>*

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Abstract: The aim of the presentation is to characterize how climate change may influence workers' allergic and respiratory health and safety and to establish plans for mitigating, responding, and adapting to the current and anticipated impacts. Workers are often the first to be exposed to the effects of climate change as they may be exposed to hazards for longer durations and at greater intensities than the rest of the populations due to their type of activities, geographic region, season, and duration of time they are outside. Climate change may result in not only the increasing prevalence and severity of known occupational hazards and exposures but also the emergence of new ones including allergic and respiratory diseases. When looking at allergic and respiratory health, hazards to which workers are particularly exposed and that are increasing due to climate change are physical (extreme heat and cold, air pollution, noise) and biological (vector-borne, pollen, molds, plants). Extreme heat and cold temperatures and air pollution are responsible for increased respiratory morbidity and mortality. In workers, extreme heat triggers asthma and extreme cold worsens COPD. Air pollution is an established trigger and cause of both asthma and COPD. Additionally, exposure to loud noise as source of stress exacerbates the effect of air pollution. More vector-borne respiratory diseases and allergies are expected. Increasing molds and pollen count and allergens will increase allergies. Thunderstorms tightening will enhance asthma occurrence due to pollen and mold sub-particles penetration in the airways. Finally, poisonous plants can cause allergic skin reactions and respiratory problems if their toxins are inhaled. Employers should train outdoor workers about their workplace hazards, including hazard identification and recommendations for preventing and controlling their exposures.

## **S01.04.27. Indoor Air Pollution from Solid Fuel Use and Children's Developmental Status in Lmics: Insights from the Multiple Indicator Cluster Survey**

Youssef Oulhote

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**Abstract:** Background: Indoor air pollution from solid fuels represents an important determinant of adverse health effects with 4.3 million premature deaths annually, and 3% of the global burden of disease. However, research on impacts of indoor air pollution on child development, including cognitive and behavioral development, is lacking. Objective: To investigate the association between children's exposure to indoor air pollution through solid fuel use (SFU) and early child development in low and middle-income countries (LMICs). Methods: We analyzed data on 102,007 children under 5 years from the multiple indicator cluster survey by UNICEF on 46 LMICs. A standardized global early child development index (ECDI) was calculated from questions on 4 developmental domains: physical, learning, social-emotional and literacy-numeracy. SFU was defined as cooking with coal/lignite, charcoal, wood, straw/shrubs/grass, animal dung, agricultural crop. We used multilevel regressions to investigate associations between SFU and ECDI by country, pooled by geographical region, and pooled globally. Results: Between 0.3% (Tunisia) and 99.5% (Central Africa) reported SFU. Overall, 31% of children were not developmentally on track. Associations between SFU and ECDI were heterogeneous across countries, and higher in Africa. Children with SFU had 0.25 standard deviation (SD) (95% CI: -0.31, -0.18), 0.27 SD (95% CI: -0.32, -0.21), 0.13 (95% CI: -0.22, -0.05), and 0.07 (95% CI: -0.14, 0) decreased ECDI scores in West & Central Africa, Middle East & North Africa, South Asia, and Latin America regions, respectively. No associations were observed for the Eastern European, East Asia and Pacific, and Eastern & Southern Africa regions. Globally, SFU was associated with 0.11 SD (95% CI: -0.18, -0.04) decrease in standardized ECDI scores. Conclusions: Although current SFU was used as a proxy and explicit exposure measurements were lacking, we found evidence that SFU negatively impacts children's early development

#### **S01.04.28. Outdoor Air Pollution in the City of Abidjan (Côte D'Ivoire): From Pollutant Concentrations to Diseases in Hospitals**

Kouame Kouadio

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**Abstract:** Background Air quality is a major concern due to its impact on human health. In order to assess the impact of air pollution on health, a survey was carried out during 2 years. The pollutants' concentrations were also estimated. PM<sub>2.5</sub> concentrations were recorded in regard to hospital admissions in order to estimate a relationship between the occurrence of the diseases and pollutants concentrations. The survey was conducted from the 2nd July 2015 to 23rd February 2017 during rainy and dry season. Daily data of patients with cardiovascular, respiratory and skin diseases from five health centers of palmeraie and Akouédo village in the municipality of Cocody, Community Hospital and Soeur Catherine hospital in Yopougon and general hospital in Adjame were recorded. Results 10,593 patients with respiratory diseases, cardiovascular and skin diseases were recorded. 54 % were female. 57% of them were under 20 years old. Concerning diseases, final diagnosis showed that 67% had respiratory diseases. Seasonal average concentrations were observed for pollutants. PM<sub>2.5</sub> concentration average was 32±24 µg/m<sup>3</sup> for traffic, 28±19 µg/m<sup>3</sup> for waste burning and 145±69 µg/m<sup>3</sup> for domestic fire; which were higher than those recommended by WHO guidelines for air quality. Correlation between hospital admission and pollutants concentrations were not observed. **Conclusions** This study is an original database to characterize urban air pollution and a first attempt toward hospital admission in the metropolis of Abidjan. This work should draw the attention of the stakeholders to the necessity of air quality monitoring in order to define national standards and to better control the pollutants' emissions and to investigate the impact on the health of the growing population of developing African countries.

#### **S01.04.29. A Time Series Analysis of Morbidity and Mortality of Lung and Cardiovascular Diseases in Kampala, Uganda**

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**Abstract:** Burden of disease attributable to non-communicable diseases (NCD) is increasing worldwide. World Health Organization 2017 report estimated 40 million deaths occur per year worldwide, and that 31 million of all these deaths occur in low and middle income countries. We provide preliminary analysis to ascertain morbidity and mortality of Lung and Cardiovascular Diseases in Kampala, Uganda. We collected data on morbidity and mortality from 3 hospitals in 2 sub cities of Kampala. These hospitals were selected on the basis of providing adequate data for emergency and regular admissions, and discharge hospital services (improved or follow up or death), serving a larger geographical catchment area, potential availability of complete data, and the presence of in house IRB in each hospital. Data from the hospitals was collected from Health Management System (HMIS) using the data abstraction from 1st September to 31st December 2017. We collected data on the health outcomes related to cause of illnesses (morbidity) and cause of deaths (mortality). Individual level variables included age, sex, date of admission, cause admission, date of discharge, cause of death, and address of the patient were analyzed using descriptive statistics. Overall 870 patients were studied and of these 53% (463/870) of the patients were male as compared to the females. The mean age was 30 years (range=0-97 years). Majority 78% (676/870) patients had respiratory related conditions, of these 51% (347/870) were children aged 0-9 years. Cardiovascular related conditions were notably higher adults  $\geq 40$  years. The most reported cardiovascular related conditions in adults were stroke and cardio pulmonary failure. The commonest cardiovascular conditions are stroke and cardio vascular failure and pneumonia is a dominant respiratory condition in children The findings will help to generate road maps and action by governments and implementing partners in control the NCD diseases in cities.

## S01.04G. Emerging Evidence on Exposures to Ultrafine Particles

### S01.04.31. Personal Exposures to Ultrafine Particles among Asthmatic Kids: Differences between UFP and PM2.5

Kirsten Koehler

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Abstract: Particulate matter (PM) air pollution is known to exacerbate asthma symptoms in children; however, it is still unclear which metric (particle size, morphology or chemical composition) of PM is most relevant to respiratory health. Most studies have focused on the health impacts of fine PM (PM<sub>2.5</sub>, particles with diameter less than 2.5  $\mu\text{m}$ ), yet recent evidence suggests that health effects may be more strongly related to the ultrafine particulate (UFP) portion of PM exposure. Due to complexities of exposure assessment and the lack of a regulatory monitoring network for UFP, few epidemiologic studies have evaluated the relationship between UFP and respiratory health. The aim of this work is to determine which factors of PM exposure, including UFP, microenvironment, and peak exposure, are associated with respiratory effects. We conducted personal exposure assessment in a panel of 15 children with asthma, each of whom were followed for 7 days with 4 days of continuous monitoring of PM (10-s resolution), geographic location via GPS, biomarkers (urinary LTE<sub>4</sub>), and 7 days of asthma symptoms reported via text message. Ultrafine PM was measured using a Partector (expressed as lung deposited surface area; CH Technologies) and fine PM mass was measured with a MicroPEM (RTI International). Inner-city children were exposed to levels of PM mass often exceeding WHO recommendations for PM<sub>2.5</sub> in indoor air (24-hr mean (N=58): 23.6  $\mu\text{g}/\text{m}^3$ ; range: 1.4-132.2  $\mu\text{g}/\text{m}^3$ ). Ultrafine particle exposures (24-hr mean (N=58): 37  $\mu\text{m}^2/\text{cm}^3$ ; range: 3-185  $\mu\text{m}^2/\text{cm}^3$ ) typically varied over 2 orders of magnitude within 24-hours and showed relatively low correlation with PM<sub>2.5</sub> (mean Pearson coefficient of 1-minute measurements across 58 sampling days was 0.29). Exposures to ultrafine particles tended to be highest at home during exposure to secondhand smoke and cooking events. Exposures while commuting were also high, especially when walking.

### **S01.04.32. Using Real-Time Personal Monitoring and Ecological Momentary Assessment to Study Ultrafine Particles and Children's Health**

Patrick Ryan

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**Abstract:** Background: Few studies have examined the health effects of ultrafine particles (UFPs), in part due to challenges in assessing exposure. The objective of the Ecological Momentary Assessment and Personal Particle Exposure Study (EcoMAPPE) is to characterize adolescents' personal exposure to UFPs and examine their association with respiratory health. Methods: Participants (ages 13-17) complete two sampling periods of seven days. On each sampling day, personal UFP exposure is measured at one-second intervals for three hours using a wearable UFP monitor (PUFP C200, EnMont, LLC). Ecological momentary assessment (EMA) data is collected using a smartphone app that prompts participants to answer brief surveys based on time, location, and activity. Participants may also record locations where they perceive elevated exposure and can upload images to provide a visual depiction of their environment. Additional sensors include the collection of GPS data; a Fitbit Charge 2 to monitor heart rate, sleep quality, and activity; and a Spirobank Smart to record lung function throughout the sampling period. Results: To date, 24 participants have enrolled in the study and, collectively, completed 458 hours of personal sampling. Personal exposure to UFP was highly variable; participants' median UFP exposures over their seven-day sampling period ranged from 1,140 - 13,000 particles / cm<sup>3</sup> (p/cc). Similarly, the 95th percentile of UFP exposure ranged from 13,600 to > 150,000 p/cc. Participants completed 1,012 EMA surveys; of these 51% were completed at home, 9% at school, 23% while in transit, and 17% at other locations. Participants recorded FEV<sub>1</sub> and peak flow 3.25 times per day, on average. Conclusions: Personal air pollution monitors, EMA, and other sensors enable the examination of short-term UFP exposure and respiratory health in adolescents.

### **S01.04.33. Ultrafine Particle Exposures in a Population of Former Smokers with COPD**

Meredith McCormack

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**Abstract:** Chronic Obstructive Pulmonary disease (COPD) is the third leading cause of death in the United States, affecting over 10 million adults, and the fifth leading cause of death worldwide. Mortality attributable to COPD is projected to increase and those with COPD suffer high morbidity, including poor quality of life, activity limitation and exacerbations leading to ED visits and hospitalizations. Individuals with COPD are susceptible to the health effects of air pollution. Exposure to indoor PM<sub>2.5</sub> has been associated with respiratory symptoms and increased risk of exacerbation. However, little is known about whether there is an independent effect of ultrafine particles on COPD morbidity. To study indoor UFP and COPD outcomes, in-home monitoring of UFP has been conducted in the homes of 35 non-smoking adults with COPD for 1-week periods. This monitoring has been done concurrently with PM<sub>2.5</sub> and NO<sub>2</sub> monitoring, providing a holistic look at air pollution exposures in this potentially susceptible population. This cohort is well characterized, comprised of former smokers with impaired lung function indicating moderate to severe COPD. Respiratory questionnaires and lung function have been obtained with simultaneous monitoring of in-home air pollution at 3 and 6 months after enrollment. Peak UFP exposures are highly correlated with cooking events and exposures typically vary over 2 orders of magnitude within a day. We will evaluate the independent effects of UFP on respiratory morbidity in this cohort of former smokers with COPD.

### **S01.04.34. Joint Effects of Long-Term Exposure to Ultrafine Particles and Nitrogen Oxides on Cardiovascular Risk Factors over Six Years among an Environmental Justice Population**

Laura Corlin

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**Abstract:** Background: No previous studies have examined the cardiovascular effects of interactions between long-term exposure to ultrafine particles (UFP, measured as particle number concentration or PNC) and nitrogen oxides (NOx). We assessed independent and joint effects of PNC and NOx on cardiovascular risk factors in a longitudinal study of Puerto Rican adults living in Boston (MA, USA). Methods: Over 940 participants attended up to 3 study visits over 6 years. Annual average PNC and NOx exposures were assigned using a model accounting for spatial (<200 m) and temporal patterns. We used multilevel linear models with random intercepts for each participant to examine the independent and joint effects of normalized PNC and NOx on systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), and an inflammation biomarker (high sensitivity C-reactive protein or CRP). Results: Median PNC was 21000 particles/cc (inter-quartile range (IQR) = 11000 particles/cc) and median NOx was 45 ppb (IQR = 12 ppb) for our participants (mean baseline age = 57 yrs, sd = 7.5; >70% female; 52% with >8th grade education). PNC was independently associated with DBP ( $\beta = 0.53$ , 95%CI = 0.09, 0.96 mmHg). NOx was independently associated with SBP ( $\beta = 1.18$ , 95%CI = 0.20, 2.16 mmHg), DBP ( $\beta = 1.02$ , 95%CI = 0.49, 1.55 mmHg), and lnCRP ( $\beta = -6.3$ , 95%CI = -13.3, 0.6% change). People exposed to high levels of both pollutants had higher SBP ( $\beta = 1.66$ , 95%CI = -0.08, 3.39 mmHg) and DBP ( $\beta = 2.47$ , 95%CI = 1.51, 3.43 mmHg) than people exposed to low levels of PNC and NOx. An interaction term for PNC and NOx was significant and indicative of antagonistic effects on DBP. There were no effects of PNC or NOx on PP. Sex, smoking status, and baseline hypertension status modified the independent and joint effects. Conclusion: Long-term exposure to PNC and NOx have independent and joint associations with blood pressure levels over six years. There is less evidence that the pollutants affect CRP.

## S01.04H. Updates on the CKDu Epidemic and New Directions for Coordinated Research

### **S01.04.35. Longitudinal Study of Workers in El Salvador & Nicaragua: Opportunities for Collaboration**

Madeleine Scammell

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**Abstract:** The causes of the epidemic of chronic kidney disease (CKD) in Central America, referred to as Mesoamerican Nephropathy (MeN), or CKD of non-traditional etiology (CKDnt), are unknown. Sugarcane workers in both El Salvador and Nicaragua are at high risk of developing the disease. However, the disease is not unique to sugarcane, nor is it limited to agricultural workers. The disease is also known to affect men of working age engaged in other sectors involving manual labor. An ongoing longitudinal study in both countries of workers in sugarcane, corn, plantain and construction will measure exposure to heat as well as a variety of nephrotoxins including pesticides and metals. The MesoAmerican Nephropathy Occupational Study (MANOS) will include a short-term exposure assessment characterizing occupational risk factors and baseline health status, and follow workers over time to monitor long-term kidney function. The presentation will emphasize aspects of the study design that allow for analyses of multiple exposures and end points, and opportunities for collaboration.

### **S01.04.36. Chronic Kidney Disease in a Multiethnic Rural Population in the United States: Translating Research from Tropical Regions**

Katherine James

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Abstract: Chronic kidney disease is a global public health concern which can lead to end stage renal disease. Known risk factors have been unable to account for all the variability in chronic kidney disease risk especially in tropical areas where an emerging epidemic is occurring. Therefore, research has expanded into examining environmental exposures as potential risk factors for chronic kidney disease. These include climate factors such as heat stress and dehydration, drinking water quality (metals, hardness, silica, fluoride), pesticide exposure (glyphosate), and health risk behaviors (smoking, non-steroidal anti-inflammatory drug use). In consideration of these factors, we are investigating the association between environmental exposure to metals and clinical and preclinical kidney disease in the San Luis Valley Diabetes Study cohort with longitudinal physiologic and behavioral data. We estimated cumulative cadmium exposure for individual study subjects using historically collected urine samples and arsenic exposure from residential drinking water based on a previously validated method. We also considered other pathophysiologic factors including diet, smoking, physical activity, family history, diabetes mellitus, hypertension, specific drug use, occupation and other contributing medical factors. If an association is identified between metal exposure and clinical and preclinical kidney disease, it can help elucidate the pathophysiology with possible linkage to the emerging epidemic in tropical regions.

**S01.04.37. Chronic Kidney Disease in El Salvador and Mesoamerica: Fostering Collaborations to Respond to the Epidemic**

Ramon Garcia Trabanino

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*1. Centro de Hemodialisis, San Salvador, El Salvador.*

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Abstract: Dr. Garcia Trabanino is the head of the Association of Nephrology of El Salvador and a board member of the CENCAM, the Consortium of researchers studying the Epidemic of Mesoamerican endemic Nephropathy (MeN) in Central America and Mexico. He will discuss research on MeN nationally and regionally, on pesticides and heat stress, as well as collaborations with community groups in El Salvador, including the Emergency Social Fund for Health (ESFH) of the town of Tierra Blanca, at the Bajo Lempa region in El Salvador, a community-based organization focused on early identification and treatment of the disease. This presentation will summarize 20 years of research history and collaborations, along with relevant clinical aspects of this new disease, including the ESHF community registry of end-stage renal disease and protocol for diagnosis and treatment of patients with MeN.

## **S01.04.38. Shining a Light on Sri Lankan CKDu: Opportunities for International Collaboration**

Keith Levine

*Keith E. Levine<sup>1</sup>, Jennifer H. Redmon<sup>2</sup>, Myles Elledge<sup>2</sup>, Rajitha Wickremasinghe<sup>3</sup>, Kamani Wanigasariya<sup>4</sup>, M. Pathmalal<sup>4</sup>, James Harrington<sup>1</sup>, Reshan A. Fernando<sup>1</sup>*

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Abstract: Chronic kidney disease (CKD) has emerged as an important non-communicable, global health epidemic. Importantly, CKD is becoming increasingly prevalent in the developing world where diagnosis and treatment of renal disease is consuming a significant and growing portion of healthcare resources. In the 1990s, an apparently new form of CKD of unknown etiology (CKDu) began to emerge in Sri Lanka's North Central Province (NCP), located within the island nation's dry zone. It is slowly progressive, initially asymptomatic, and irreversible, directly impacting approximately 30K people to date, and growing. Sri Lankan CKDu is also characterized by renal tubular/interstitial damage, primarily burdening people of lower socioeconomic status working or living in agricultural areas. This presentation will review findings from CKDu field work in Sri Lanka (2013-14 and 2017) in targeted geographic areas. Biological (blood and urine) and environmental samples (drinking water, rice, soil and freshwater fish) from endemic areas in Sri Lanka were analyzed to determine the concentration of a suite of heavy metals and trace element nutrients, along with qualitative research of household health and farming practices. A broad panel, mineralomics approach was used to shed light on potential geochemical risk factors associated with CKDu.

Tuesday, August 28

WHO Global Strategy on Health, Environment and Climate Change

*Maria Neira, World Health Organization (WHO), Director for the Department of Public Health, Environmental and Social Determinants of Health*

Abstract: Environmental risk factors cause about one quarter of deaths world-wide, amounting to 13 million deaths each year. Ambient and household air pollution together cause 7 million deaths per year. 829,000 annual deaths still results from easily preventable risks linked to poor water, sanitation and hygiene. A large fraction of malaria, dengue and other vector diseases are closely linked to aquatic environments. Adverse health impacts from chemicals are continuously identified. Over half of the world population live in urban areas, which will increase to over 70% by 2050. The threats of climate change to health are multi-faceted and rapidly increasing in intensity. A transformative approach is needed to address environmental risks to health at their root, at the level of policy setting, in an integrated way. Sectors which define policies highly impacting on population health include the energy, transport, land use planning, housing, water and sanitation, labour and industry. Accumulating evidence on impacts and solutions and the Sustainable Development Goal (SDG) Agenda are creating the opportunity for change. Evidence on notable successes from solutions to critically reduce this burden has increased, and is showing high returns from investments in safer environments. Our vision is an overarching framework and set of governance mechanisms and leadership for health, and stepped up, broad intersectoral stakeholder engagement and action to implement health-supportive policies. Such actions are to be based on a solid evidence base of health impacts and solutions, and informed by regular monitoring and tracking. New research connected to interventions in health-relevant areas, implementation science and participatory policies are necessary to accelerate the attainment of the SDGs. Research, together with strengthened advocacy, communication and awareness raising around the co-benefits from actions on health, environment and climate change is essential to trigger for long-term sustainable solutions.

## How Can Birth Cohort Studies Contribute to Knowledge and Policies of the World to Reduce Risks of Emerging Contaminants?

*Shoji Nakayama, National Institute for Environmental Studies, Japan*

**Abstract:** A number of epidemiologic studies have revealed the environment can affect child health and development. Exposure to specific chemical substances during foetal and early childhood may cause health problems in later life. Children have unique exposure characteristics such as specific routes of exposure (e.g. through placenta and breastfeeding), exploratory behaviours (e.g. hand-to-mouth, object-to-mouth, pre-ambulatory and high-risk behaviours) and specific physiology (e.g. high oxygen demand, high breathing rate, low stature and high surface area to volume ratio). Understanding how children expose to harmful environment qualitatively and quantitatively and how the exposure associates with child health and development is essential for children's environmental health. Contaminants of emerging concern (CECs) in human health context are groups of chemical substances that existed in the past but with new concern and that are introduced to market recently and concerned to have potentially harmful effects. For example, lead is a legacy contaminant but has posed new concern about its effect on child neurological development at relatively low exposure. Particulate matter is not a single chemical but a long-lasting pollutant that appears to affect children's lung function at low level exposure. Algal toxins are another legacy group of chemicals with new health concern. Examples of newly introduced chemicals include pesticides, pharmaceuticals and personal care products, fragrances, plasticisers, hormones, flame retardants, nanoparticles, poly- and perfluoroalkyl compounds, chlorinated paraffins, siloxanes and various trace elements including rare earths. To better characterise the effect of the CECs on child health and development, many researches have been initiated in Asian countries as well as North America and Europe. Some studies look at a single to few CECs and others do many CECs simultaneously. Some studies characterise foetal exposure and others start from birth. Some studies evaluate health outcomes in trajectory, e.g. growth curves and changes in developmental scores. Some uses advance statistical methodologies to analyse the effect of multiple contaminants that potentially correlate each other. In this presentation, a potential of birth cohort studies on addressing risks of CECs will be discussed.

## 002.01A. Air Pollution and Diabetes

### 002.01.01. Inflammation and Acute Traffic-Related Air Pollution Exposures among a Cohort of Youth with Type 1 Diabetes

Robin Puett

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**Abstract:** Background Evidence remains equivocal regarding the association of inflammation, a precursor to cardiovascular disease, and acute exposures to ambient air pollution from traffic-related particulate matter. Though youth with type 1 diabetes are at higher risk for cardiovascular disease, the relationship of inflammation and ambient air pollution exposures in this population has received little attention. Objectives Using five geographically diverse US sites from the racially- and ethnically-diverse SEARCH for Diabetes in Youth Cohort, we examined the relationship of acute exposures to PM<sub>2.5</sub> mass, Atmospheric Dispersion Modeling System (ADMS)-Roads traffic-related PM concentrations near roadways, and elemental carbon (EC) with biomarkers of inflammation including interleukin-6 (IL-6), c-reactive protein (hs-CRP) and fibrinogen. Methods Baseline questionnaires and blood were obtained at a study visit. Using a spatio-temporal modeling approach, pollutant exposures for 7 days prior to blood draw were assigned to residential addresses. Linear Mixed Models for each outcome and exposure were adjusted for demographic and lifestyle factors. Results Among the 2566 participants with complete data, fully adjusted models showed positive associations of EC average week exposures with IL-6 and hs-CRP, and PM<sub>2.5</sub> mass exposures on lag day 3 with IL-6 levels. Comparing the 25th and 75th percentiles of average week EC exposures resulted in 8.3% higher IL-6 (95%CI: 2.7%,14.3%) and 9.8% higher hs-CRP (95%CI: 2.4%,17.7%). We observed some evidence of effect modification by gender for PM<sub>2.5</sub> mass exposures with hs-CRP and by race/ethnicity for EC. Conclusions Inflammation was associated with PM<sub>2.5</sub> mass and traffic-related air pollution in this study population of youth with type 1 diabetes. Thus youth with type 1 diabetes may be at increased risk of cardiovascular outcomes in areas with poorer air quality. The racial/ethnic and gender differences observed deserve further exploration.

## **O02.01.02. A Longitudinal Cohort Study on the Association between Long-Term Exposure to Ambient Fine Particulate Matter (PM2.5) and Diabetes Development**

Xiang Qian Lao

*Xiang Qian Lao*<sup>1</sup>

*1. The Chinese University of Hong Kong, Hong Kong, Hong Kong.*

**Abstract:** A longitudinal cohort study on the association between long-term exposure to ambient fine particulate matter (PM2.5) and diabetes development Xiang Qian Lao 1, \*, Cui Guo 1; Yacong Bo 1 ; Zilong Zhang 1 1. School of Public Health and Primary Care, the Chinese University of Hong Kong, Hong Kong Background There is limited information on the effects of long-term exposure to PM2.5 on the development of diabetes, especially in the WHO Western Pacific and South-East Asia regions, where many countries are experiencing high levels of air pollution. This study aimed to investigate the association between PM2.5 and incident diabetes using a large-scale longitudinal cohort study in Taiwan. Method We recruited around 150,000 participants at least 18 years of age between 2001 and 2014. Each participant received at least two measurements of fasting plasma glucose (FPG). Incident diabetes was identified as FPG $\geq$ 126 mg/dl, or self-reported physician-diagnosed diabetes. We estimated PM2.5 concentrations at each participant's address using a satellite-based spatiotemporal model with a resolution of 1  $\times$  1 km<sup>2</sup>. We performed Cox regression models with time-dependent covariates to analyse the effects of long-term to PM2.5 on the incidence of diabetes. Results Every 5- $\mu$ g/m<sup>3</sup> increase in PM2.5 was associated with a 5% higher risk of diabetes (hazard ratio [HR]: 1.05; 95% confidence interval [CI]: 1.03 to 1.07). Compared with the participants who exposed to the 1st quartile of PM2.5, participants with the exposure to the 2nd, 3rd and 4th quartiles of PM2.5 had HRs of 1.26 (95% CI: 1.17 to 1.37), 1.27 (95% CI: 1.17 to 1.37) and 1.15 (95% CI: 1.06 to 1.25), respectively, in the incidence of diabetes. Participants who drank occasionally or regularly (more than once per week) and had a lower body mass index (<23 kg/m<sup>2</sup>) were more sensitive to the effects of long-term exposure to ambient PM2.5. Conclusion Long-term exposure to ambient PM2.5 is associated with an increased risk of diabetes development.

### **O02.01.03. Long-Term Exposure to Ambient PM2.5 and Incidence of Diabetes in China: A Cohort Study**

Fengchao Liang

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**Abstract:** Background: Fine particulate matter (PM2.5) exposure has been linked to increased risk of various diseases. However, associations between air pollution and the chronic development of diabetes were rarely reported, especially in China. In this work, a cohort-based study was conducted to assess the incidence of diabetes associated with long-term exposure to ambient PM2.5. Methods: We collected health data and risk factors from the project of Prediction for Atherosclerotic Cardiovascular Disease Risk in China (China-PAR Project), with a sample of 127,840 Chinese adults aged 35 to 74 years studied. To match our PM2.5 exposure data, follow-up information from 2004 to 2015 was analyzed. Individual levels of PM2.5 exposure were estimated from satellite-based PM2.5 concentrations at 10 km resolution. Time-weighted average level based on each subject's geocoded addresses during the study period was presented as the long-term exposure of PM2.5. Cox proportional hazards model was employed to estimate the incidence of diabetes attributable to long-term exposure of PM2.5, with age, gender, smoking status, education level, body mass index and long-term levels of temperature and relative humidity adjusted. Nested random intercept of study cohorts and clusters were fitted in the model. Results: With 553,303 person-years of follow-up after 2004, the incidence of diabetes was 11.5 and 11.6 per 1000 person-years in men and women, respectively. For an increase of 10 µg/m<sup>3</sup> in long-term PM2.5 exposure, the adjusted percent increase in the incidence of diabetes was 15.05% (95% confidence interval: 6.10%, 24.75%). The increases were larger among the women, non-smokers and the subjects who were living in rural areas. Conclusions: Long-term exposure to ambient PM2.5 is a risk factor for diabetes in China. A sustained improvement of air pollution may benefit for the reduction of diabetes incidence in population.

**O02.01.04. Associations between Traffic-Related Air Pollution and Cardiovascular Disease Risk Factors Were Stronger in More Walkable Neighborhoods: The Cardiovascular Health in Ambulatory Care Research Team (CANHEART)**

Nicholas Howell

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**Abstract:** Introduction Studies suggest living in a more walkable neighborhood may protect against cardiovascular disease risk factors such as hypertension (HTN) and diabetes mellitus (DM) by encouraging physical activity. Walkable neighborhoods, however, often carry higher levels of traffic-related air pollution. Little is known regarding whether synergistic effects may exist between walkability and air pollution on these risk factors. Hypothesis We hypothesized that the association between traffic-related air pollution, hypertension, and diabetes mellitus would be stronger in more walkable areas. Methods We drew a cross-sectional sample of individuals ages 40-74 on January 1, 2008 from the CANHEART cohort. HTN and DM were ascertained using validated algorithms. Walkability (quintiles, Q5 highest, Q1 lowest) was measured using a validated index which has previously been shown to be inversely associated with obesity and diabetes. Exposure to nitrogen dioxide, a valid marker for traffic-related air pollution, was assessed using a land use regression models. The associations were tested using logistic regression with cluster-robust standard errors, adjusting for age, sex, area-level income, ethnicity, and comorbidities. Results 2,618,584 individuals were included in the analysis. Walkability was inversely associated with odds for HTN (Q5 vs. Q1 OR = 0.80, 95% CI: 0.79, 0.82) and DM (Q5 vs. Q1 OR = 0.89, 95% CI: 0.87, 0.91), while NO<sub>2</sub> was positively associated with each (HTN: OR = 1.02 per 10 ppb (1.01, 1.03); DM: OR = 1.11 per 10 ppb (1.09, 1.13)). We observed significant interactions between walkability and NO<sub>2</sub> on odds for HTN and DM, with stronger NO<sub>2</sub> associations in the most walkable neighborhoods. Conclusions We observed significant interactions between traffic-related air pollution and walkability on odds for HTN and DM. This finding suggests that benefits from living in more walkable neighborhoods may be partially offset by stronger negative associations with air pollution.

## **O02.01.05. Childhood Type 1 Diabetes: An Environment Wide Association Study across England**

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**Abstract: Background/Aim:** Type 1 Diabetes (T1D) is an autoimmune disease with ~400,000 people currently affected across the UK. T1D results from gene-environment interactions, with environmental factors likely triggering the disease process in genetically susceptible individuals. We aim to assess the influence of a wide range of environmental factors on childhood T1D incidence in England, using an agnostic Environment Wide Association Study (EWAS) approach. **Methods:** We undertook an ecological EWAS at the Local Authority District (LAD) level (average ~140,000 persons, N=354) using incident T1D data derived from the national inpatient Hospital Episode Statistics. We assessed the association of LAD-level T1D incidence with a range of environmental exposures including meteorological, demographic, land use and pollution variables. Associations were assessed via Negative Binomial regression, using the age-sex adjusted expected counts as the offset. **Results:** Over the study period April 2000 - March 2011, there were 13,948 eligible T1D cases aged 0-9 years old. Case counts by LAD varied from 1 to 236; with a median 33 (Inter Quartile Range: 24-46), with an overall incidence of 21.2 (95% CI 20.9-21.6) per 100,000. The EWAS indicated that 25 out of the 58 environmental exposures were significantly associated with T1D incidence after adjusting for multiple testing using the Bonferroni correction. These included the air pollutants particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), nitrogen dioxide, carbon monoxide as well as light at night pollution, UV radiation, lead in soil, population density and ethnicity. **Conclusions:** Our analysis contributes to evidence that a range of environmental exposures are associated with T1D in children in England. Variables identified as associated with T1D incidence via this agnostic, hypothesis generating, ecological EWAS approach are being further assessed at the individual level in a case control study.

## 002.01B. Air Pollution Related Hospitalization, Mortality, and Life Expectancy

### **002.01.06. Mortality and Hospitalization Linked to Fine Particulate Matter in Canada: Is There a Trend in Risk between 2001 and 2012?**

Hwashin Shin

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**Abstract:** Background: The Air Health Trend Indicator is designed to estimate public health risk related to short-term exposure to air pollution and to detect trends in annual national health risks. Trends in risk may reflect changes over time in population susceptibility or in composition of fine particulate matter or more generally in the air pollution mix. Design: Daily PM<sub>2.5</sub>, mortality, morbidity, and weather data for 22 cities (about 50% of the total population) were collected for 2001-2012. A Bayesian hierarchical model was employed to estimate annual national associations by season, lag of effect, sex and age group ( $\leq 65$  vs  $>65$ ). Circulatory (ICD\_I00-I99) and respiratory (ICD\_J00-J99) causes were examined for both mortality and morbidity (hospital admissions). Results: Annual population weighted PM<sub>2.5</sub> concentrations decreased gradually by 14% from 8 to 7  $\mu\text{g}/\text{m}^3$  nationally over the 12 year period. While population has increased by 13%, the ratios of mortality and morbidity to the population have decreased by 6% and 14%, respectively. In relation with PM<sub>2.5</sub> both mortality and morbidity showed higher circulatory risk for cold season, higher respiratory risk for warm season, higher risk for seniors ( $>65$ ), and sex-specific differences. Females were at higher risk (1.9% vs 1.1% per 1  $\mu\text{g}/\text{m}^3$ ) for circulatory mortality but males were at higher risk (0.26% vs 0.02%) for respiratory morbidity. No apparent trends were observed in PM<sub>2.5</sub> risk over time. Discussions: Despite downward trends in PM<sub>2.5</sub> concentrations, mortality and morbidity rates, there was no apparent trend in PM<sub>2.5</sub> risk. The 12-year period may be not long enough to detect trends if they exist. While the age difference in risk has been consistently reported, the sex difference has been inconsistent and thus needs further investigation. These findings could differentiate adverse effects of PM<sub>2.5</sub> on mortality and morbidity by identifying sub-populations susceptible to PM<sub>2.5</sub> by season, age, and sex.

## **002.01.07. Exploration on Explanations for Observed Long-Term Temporal Trend of the Short-Term Association between Fine Particulate Matter Concentration and Hospital Admissions in the U.S.**

Chen Chen

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**Abstract:** Background In earlier work, we examined whether the PM<sub>2.5</sub>-hospital admissions relative risk varies over time, using hospital admission data of U.S. Medicare beneficiaries and U.S. Environmental Protection Agency PM<sub>2.5</sub> monitoring data. When assuming a linear temporal trend, the change in respiratory hospital admissions per 10 µg/m<sup>3</sup> increase in same day PM<sub>2.5</sub> decreased by 1.77% (95% CI: 0.92 to 2.63%) from the year 1999 to the year 2013, while no statistical significant temporal trend was observed for cardiovascular hospital admissions. To better understand drivers behind the observed temporal trends, this study provides details in our model specifications, as well as exploration on explanations to these observations. Methods To ensure internal validity of the modified Bayesian hierarchical model used, we conducted extensive sensitivity analyses with hypotheses tested stated a priori. Based on previous literatures and biological plausibility, we proposed and evaluated four possible explanations for the decreasing temporal trend for respiratory admissions as well as the lack of temporal trend for cardiovascular admissions: 1) the increase in relative measurement error at lower level of PM<sub>2.5</sub> concentration; 2) flattening of concentration-response function at lower level of PM<sub>2.5</sub> concentration; 3) change in chemical composition of PM<sub>2.5</sub> total mass; 4) change in population susceptibility towards acute exposure to PM<sub>2.5</sub> on respiratory adverse health outcomes. Results and conclusions Based on qualitative evidence, changes in population susceptibility towards acute exposure to PM<sub>2.5</sub> on respiratory adverse health outcomes, and combination of changes in multiple chemical components may partially explain the observed temporal trend. Future research should consider distributed lag model and non-linear concentration response functions, which will require additional exposure data.

## **002.01.08. A National Study of the Mortality Effects of PM2.5 on All-Cause and Cause-Specific Mortality in the Contiguous U.S.**

Helen Tamura-Wicks

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**Abstract:** Background The adverse health effects of air pollution are established at the individual level, and at the population level in major metropolitan areas. However, the effect on all-cause and cause-specific mortality for the entire country has not been directly evaluated. We investigate the effects of air pollution on mortality for the entire population in the contiguous USA. Methods We used number of deaths for 1999-2011 from the U.S. National Center for Health Statistics (NCHS). Corresponding age-sex-specific population counts were from the US Census Bureau and the NCHS. Annual mean PM2.5 concentrations were estimated by incorporating remotely-sensed and in-situ observations into a land-use regression model. We applied a Bayesian spatiotemporal model to age-sex-county-specific death rates, to estimate the effects of county annual mean PM2.5 concentration on all-cause and cardiopulmonary mortality. The model was formulated to empirically smooth death rates over age and county of residence. We adjusted for poverty, race, income and lung-cancer mortality as a proxy for smoking. Results In unadjusted analysis, all-cause death rates increased by 4.4% (95%CI 3.9-4.9%) for males and 2.5% (95%CI 2.0-3.0%) for females, per 10 $\mu$ g $m^{-3}$  higher PM2.5. Age-specific rate ratios smoothly varied with age, with rate ratios highest in males aged 60-64 years and females 65-69 years. Cardiopulmonary death rates increased by 2.2% (95%CI 1.1 to 3.1%) for males and 0.5% (95%CI -0.4 to 1.4%) for females (all confounders and education). Age-specific proportional effects were largest for males aged 45-49 and females 50-54 per 10 $\mu$ g $m^{-3}$  higher PM2.5. Conclusion In this first direct population-level study for an entire country we found that air pollution increases the risk of deaths from major cause of death.

## **002.01.09. Respiratory and Cardiovascular Diseases Mortality and Long-Term Exposure to Ambient Air Pollution: A 12-Year Cohort Study in Northern China**

Xi Chen

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Abstract: Cohort evidence linking long-term exposure to ambient air pollution and mortality has come largely from the United States and European countries. There is relatively little evidence from nationally representative cohorts in the high level exposure areas. We aim to investigate the associations between long-term exposures to high level ambient air pollutants and mortality of respiratory and cardiovascular diseases mortality in a cohort of Northern China. A total of 39,054 participants aged 40-89 years were followed from 1998-2009. Annual average concentrations for PM<sub>10</sub>, NO<sub>2</sub>, and SO<sub>2</sub> were determined based on data collected from central monitoring stations. Hazard ratios (HRs) for nonmalignant respiratory, lung cancer mortality and cardiovascular mortality for pollutants were estimated from Cox models adjusting for age at baseline, gender, BMI, education, marital status smoking status, personal incomes, occupation exposure, alcohol consumption and diet habits. Nonmalignant respiratory disease mortality was significantly associated with PM<sub>10</sub> (HR 1.461, 95% CI 1.296-1.648), borderline significant with SO<sub>2</sub> (HR 1.105, 95% CI, 1.022-1.195) in northern China. For each 10µg/m<sup>3</sup> increase in PM<sub>10</sub>, the relative risk ratios (RRs) of all-cause mortality, cardiovascular disease mortality, ischemic heart disease mortality, heart failure disease mortality, and cerebrovascular disease mortality were 1.24 (95% CI, 1.22-1.27), 1.23 (95% CI, 1.19-1.26), 1.37 (95% CI, 1.28-1.47), 1.11(95% CI, 1.05-1.17), and 1.23(95% CI:1.18-1.28), respectively. Each 10mg/m<sup>3</sup> increase in PM<sub>10</sub> concentrations was associated with a 3.4%-6.0% increase in lung cancer mortality in the time-varying exposure model and a 4.0%-13.6% increase in the baseline exposure model. Substantial differences exist in the risk estimates for participants based on assignment method for air pollution exposure. Further research that focuses on exploring dose-response relationship and inter-population comparisons is warranted.

## **O02.01.10. Estimating the Causal Effects of PM2.5 on Life Expectancy**

Joel Schwartz

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**Abstract:** Background: Many cohort studies have reported associations between PM2.5 and the hazard of dying, but few have used formal causal modeling methods, estimated marginal effects, or directly modeled the loss of life expectancy. Methods: Using all 16,965,154 Medicare beneficiaries in the Northeastern and Mid-Atlantic states (129,341,959 person years of follow-up, 6,334,905 deaths) we fit separate IPW weighted logistic regressions estimating the risk of dying at that age for each year of age, using PM2.5 exposure estimated at the Zip code of residence in that year for each participant. This provides a nonparametric estimate of the distribution of life expectancy as a function of PM2.5. We used Monte Carlo simulations to estimate confidence intervals. Results: The difference in the mean age at death between a counterfactual exposure to 12  $\mu\text{g}/\text{m}^3$  and 7.5  $\mu\text{g}/\text{m}^3$  was 0.85 years (95% CI 0.84, 0.86). The percent of the population that died at or before age 75 was 3.3% higher at 12  $\mu\text{g}/\text{m}^3$ . In comparison, between 2006 and 2015 U.S. life expectancy at age 65 increased by 0.7 years. Conclusions: We believe that this is the first study to directly estimate the effect of PM2.5 on the distribution of age at death using causal modeling techniques to control for confounding. We find that reducing air pollution concentrations below the current U.S. annual standard would substantially increase life expectancy in the Medicare population.

## 002.01C. Methods in Occupational Exposure Assessment

### **002.01.11. Assessing Diesel Particulate Matter Exposure by a Multi-Metric Approach in Three Different Workplaces in Québec (Canada)**

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**Abstract:** Elemental carbon and total carbon are the surrogates usually used to assess diesel particulate matter (DPM) exposure, but the measurement of different indicators by direct-reading instruments (DRI) is also described and includes advantages and limitations. The aim of this study was to assess and compare several indicators of DPM exposure in three workplaces by using a multi-metric approach. Three workplaces in Quebec (Canada) were evaluated: An underground mine (W1; n=12), a subway tunnel (W2; n=12) and a truck repair workshop (W3; n=12). Ambient particle number concentration (PNC), submicron particulate matter (PM1), and submicron elemental carbon (EC1-DRI) were measured by DRI. Filter-based samples (FBS) were also collected to estimate the respirable and submicron fractions of elemental carbon (ECR and EC1-FBS), as well as the respirable and submicron fractions of total carbon (TCR and TC1). The geometric means of the DRI were: 128,000; 32,800 and 22,700 particles/cm<sup>3</sup> for PNC in W1, W2 and W3, respectively; 165, 20.4 and 6.9 µg/m<sup>3</sup> for PM1; and 148, 25 and 4.1 µg/m<sup>3</sup> for EC1-DRI. W1 also had the highest concentrations of ECR, EC1-FBS, TCR and TC1. EC1-DRI showed the strongest association with EC1-FBS when considering all workplaces ( $\rho = 0.966$ ;  $p < 0.001$ ), but this association decreased at lower concentrations of DPM. PM1 ( $\rho = 0.936$ ;  $p < 0.001$ ) and PNC ( $\rho = 0.871$ ;  $p < 0.001$ ) also showed a strong positive correlation with EC1-FBS. Ratios of 1.05, 1.76 and 1.30 were calculated between TC1/PM1 for W1, W2 and W3, respectively. This study provided solid information about the concentrations, as well as their associations, of several indicators of DPM exposure in three different exposure contexts.

## **002.01.12. Estimating Personal Exposures with a Multi-Hazard Sensor Network in a Manufacturing Facility**

Christopher Zuidema

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**Abstract:** Industrial Hygienists conduct personal sampling to assess if workplaces are in compliance with occupational exposure limits. However, personal sampling is expensive, burdensome to employees, and generally suffers from low sample size. To overcome these shortfalls of personal sampling, we have devised a technique to estimate personal exposure by combining two pieces of data: hazard maps from a wireless sensor network (WSN) and worker location information. The study site was 75,000 m<sup>2</sup> within a heavy-vehicle manufacturing facility where processes included cutting, welding, machining, grinding and abrasive blasting. We developed and deployed a spatially-optimized, 40-node WSN with low-cost sensors for particulate matter (PM; SHARP GP), carbon monoxide (CO; Alphasense CO-B4), oxidizing gases (O<sub>3</sub> + NO<sub>2</sub>; Alphasense OX-B431), and noise (custom sensor) to map hazards inherent in these processes. We generated personal exposure estimates by combining hazard maps with location information recorded by study staff as they simulated workers moving throughout the facility. To make comparisons with personal measurements, study staff also wore direct-reading instruments (DRIs; PM: Thermo pDR-1500; CO: Lascar CO-300 EasyLog; O<sub>3</sub>: 2BTechnologies POM; Noise: Larson-Davis Spark 703+). Three field campaigns produced between 147 and 212 pairs of network-derived estimates and DRI measurements (both 5-min averages) for each hazard. The hazard ranges measured by the DRIs were: 0.110-0.990 mg/m<sup>3</sup> PM, 2-17 ppm CO, 0-57 ppb O<sub>3</sub>, and 71-89 dBA. We observed 59% of PM, 90% of CO, 0% of O<sub>3</sub>, and 100% of noise estimates were within 50% of the DRI measurement. Our WSN built with low-cost sensors was able to map occupational hazards with a high degree of spatial and temporal resolution. Combined with a method to collect location information, we have demonstrated that WSNs can be used to generate personal estimates of occupational exposures that, for some hazards, compare favorably to personal sampling.

## **O02.01.13. The Application of the Spectrosome Approach to the Evaluation of Occupational Co-Exposures to Multiple Chemical Agents**

Delphine Bosson-Rieutort

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**Abstract:** The occupational environment represents an important source of exposure to multiple hazards for workers' health. Although it is recognized that mixtures of agents may have different effects on health as compared to single agents, studies continue to focus on individual exposures. The objective was to provide a portrait of occupational co-exposures occurring in the United States, based on the largest multi-industry occupational exposure databank of the Occupational Safety and Health Administration (OSHA). From the Integrated Management Information System (IMIS) of OSHA, measurement data from workplace inspections occurring from 1979 to 2015 were retrieved. The 'workplace situation' (WS) was defined as a job title within a company within a year. Co-exposures were identified by looking at measurements within each WS. To summarize the analyses across all WSs, we used the Spectrosome approach, a new methodology inspired by big data and network science, which relies on the transformation of the data into a network. Among the 346,692 detectable exposure measurements recorded into IMIS, we found 130 690 individual WSs, 30% of which had exposure to at least two agents (up to 39). Among these co-exposures, 5 507 unique combinations of agents were found. The most frequent include co-exposures between metals such as cadmium, lead, iron oxide, manganese, copper, zinc and chromium. However, co-exposures between certain solvents such as acetone, benzene, toluene, and xylene, and also co-exposures between metals and solvents were observed. We also found that metals were associated with dusts and gases, and solvents with styrene and gases. Isocyanates were not found in association with any other class of agents. The spectrosome approach is a powerful data exploration and visualization tool for complex data. This approach enabled quantification and characterization of patterns of co-exposures in the IMIS databank, and revealed frequent occurrences of co-exposures in workplaces in the US.

## **002.01.14. Systematic Evaluation of Bias Associated with a Multiple Imputation Approach for Estimating Missing Exposure Data**

Pamela Dopart

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**Abstract:** Introduction: Occupational exposure data frequently include missing or incomplete measurements that, if not addressed, can result in an increased potential for exposure misclassification. Standard approaches for handling missing data, including complete-case analysis and mean substitution, have known limitations. This presents an opportunity to evaluate the use of more advanced statistical approaches, including multiple imputation (MI). Methods: We systematically evaluated a MI approach for addressing missing exposure data using a uniquely large and complete dataset of >1 million radiation measurements collected on workers in the skilled trades at three shipyards from 1975-2005. The original dataset contained no missing exposure information and thus represented the true exposure levels in the population. We performed a series of simulations in which 10-99% of the radiation measurements were randomly replaced with missing values and then imputed. To evaluate the performance of MI, estimates of the mean, median, 25th and 75th percentiles, and variance were calculated for each imputed dataset and compared to the true values of each metric to obtain estimates of the raw and relative bias. Results: For the simulations in which 10-95% of the measurements imputed, the raw bias of the mean ranged from -3.0 to -0.3 (relative bias: 2-15%), the raw bias of the median ranged from -3.0 to 0.0 (relative bias could not be calculated), and the raw bias of the variance ranged from -7.1 to 6.6 (relative bias: 0.1-7.4%). For the simulations in which >95% of the measurements imputed, the magnitude of the biases varied widely for each metric and were not informative. Conclusion: MI was shown to perform well in characterizing the true distribution of exposures, even when large percentages of radiation measurements were imputed. Our results, combined with the statistical advantages of model-based approaches, support the use of MI for addressing missing occupational exposure data.

## **O02.01.15. Assessment of Occupational Exposure to Endocrine Disrupting Agents**

Martie van Tongeren

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Abstract: Endocrine disrupting chemicals (EDCs) are exogenous substances that cause adverse health effects through interference with the endocrine system. Exposure to EDC can occur through various pathways, with occupational exposures potentially contributing the highest dose in adults. It has been suggested that we should classify EDCs by biological changes resulting from exposure. EDCs may directly affect the endocrine system via antagonizing and/or mimicking the effect of hormones; disrupting the production, metabolism and transport of hormones or disrupting the production of hormone receptors. For a Canadian study of occupational EDC exposures and the risk of colorectal cancer, we aim to assess occupational exposure to EDCs using the Canadian Job-Exposure Matrix (CANJEM), a newly developed job exposure matrix (JEM) built from expert evaluations of over 30,000 jobs. The CANJEM provides estimates of exposure in specific time periods to a list of 258 agents. In parallel, a crude JEM was developed in the UK by van Tongeren et al (2002) to assess occupational exposure to EDC, which was improved by Brouwers et al in 2008. Based on this EDC-JEM, we have identified and classified 30 CANJEM agents with potential endocrine disrupting effect into five classes: pesticides, polychlorinated organic compounds, phthalate, alkylphenolic compounds and heavy metals. This paper will present a proposed scheme to improve assessment of exposure and risk, by classifying these CANJEM agents according to their potential estrogenic (E), androgenic (A), anti-estrogenic (-E) and anti-androgenic (-A) effects. We will further review the evidence to assess the strength of the endocrine disrupting potential (weak, strong, uncertain). As interest increases in understanding differences in health outcomes between men and women, the availability of an exposure matrix that incorporates some estimate of endocrine disrupting potential will add immeasurably to our understanding of these differences.

## O02.01D. Predicting Indoor Particulate Matter Concentrations

### O02.01.16. Modelling Indoor PM<sub>2.5</sub> and BC in Slum Homes of Mumbai, India

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Abstract: Slums which house >50% of the population in Mumbai city (~20 million), are mostly located in the peripheries of major traffic arteries thus facing high risk to air pollution. The objective of this paper is hence to identify the determinants of indoor PM<sub>2.5</sub> and black carbon (BC) in the slum homes and develop predictive indoor models for the same. Multivariate regression models are developed using log-transformed indoor measurements in 40 non-smoking homes and outdoor measurements at a background site in a slum in Mumbai, information on S.E.S. characteristics, building characteristics and activity patterns and publicly available data from central air monitors and geographic information system. Outdoor concentration in the slum is the crucial determinant of both indoor PM<sub>2.5</sub> and BC. Outdoor PM<sub>2.5</sub> is influenced by the proximity to all major roads (especially the internal major roads with congested traffic) whereas BC is influenced by the proximity to the major roads with significant truck traffic. Number of windows and presence of exhaust fan outlets on the wall increased the indoor PM<sub>2.5</sub>, suggesting increased infiltration of outdoor PM<sub>2.5</sub> at higher air exchange rates. Surprisingly, none of the indoor pollutant sources (cooking, incense burning etc.) have a significant impact on 24-hour PM<sub>2.5</sub> or BC. The study demonstrates that the indoor slum PM<sub>2.5</sub> levels could be reasonably estimated (adj R<sup>2</sup>=0.61, RMSE=0.24) using the publicly available ambient monitoring data, GIS based local traffic information, S.E.S. characteristics and home ventilation characteristics. The results show that outdoor pollution remains an important determinant for indoor air pollution in slums. Improving the traffic circulation along the congested inner roads of slum there by reducing local outdoor air pollution and ventilation control in homes during peak traffic hours may be feasible control options.

## **002.01.17. Factors Associated with Airborne Particulate Matter Concentrations in Peri-Urban Guatemala**

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**Abstract:** Background: Exposure to ambient and household air pollution is the fourth and fifth leading cause of death worldwide and in Guatemala, respectively. In urban Guatemala, over half of households use woodstoves for cooking. Therefore, we explored associations between particulate matter (PM<sub>2.5</sub>) and stove usage in peri-urban Guatemala. Methods: We conducted a cross-sectional study among 60 households using wood and liquid petroleum gas (LPG) stoves. We measured PM<sub>2.5</sub> every 1 minute over a 1-week period using the UCB-PATS photoelectric particle monitor (Berkeley Air) and calculated the proportion of wood versus gas stove usage using iButton temperature sensors (Maxim Integrated) placed on all stoves to log temperature every 5 minutes continuously for 6 months. Results: Lower gas stove usage was associated with elevated kitchen PM<sub>2.5</sub>. Even among exclusive LPG stove households who did not use a woodstove, the median (range) 24-hour PM<sub>2.5</sub> was 71.5 µg/m<sup>3</sup> (65.7-111.9) indicating high ambient air pollution from other sources, such as traffic sources and neighboring homes using woodstoves. Compared to recent stove purchasers, households owning LPG stoves for 1-5 years used the LPG stove less (3.4 hours or 8% of total cooking time), whereas those owning a LPG stove for over 10 years used it 2.2 hours more per week (12% of total cooking time). These differences were associated with parallel trends in PM<sub>2.5</sub> (median (IQR) in µg/m<sup>3</sup>): 125.1 (79.7-186.7) for recent purchasers, 166.2 (85.5-535.5) for gas stoves owned 1-5 years and 101.8 (85.1-191.7) for gas stoves owned >10 years. Conclusions: Even with exclusive gas stove use, PM<sub>2.5</sub> remained well above WHO guidelines (annual mean concentration 35µg/m<sup>3</sup>) set to protect human health. Thus, there is a need for national and local efforts to reduce air pollution from both cooking and non-cooking sources. Additionally, as gas stoves were used least among those owning it 1-5 years, this may signal a critical time to avoid stove dis-adoption.

## **O02.01.18. Global Estimation of Exposure to PM2.5 from Household Air Pollution**

Matthew Shupler

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**Abstract:** Background: Household air pollution (HAP) exposure from cooking with dirty fuels is a major global health risk factor. Epidemiological studies have demonstrated significant variation in particulate matter concentrations of diameter  $\leq 2.5$  micrometers (PM2.5), an important metric for using integrated exposure-response functions to assess risks. To characterize global HAP-PM2.5 exposures, novel estimation methods are needed, as financial/resource constraints render it difficult to monitor exposures in all relevant areas. Methods: A Bayesian, hierarchical HAP-PM2.5 global exposure model was developed using kitchen and female HAP-PM2.5 exposure data available in published, peer-reviewed studies. Cooking environment characteristics and quantitative HAP-PM2.5 measurements from 47 studies were used to model urban and rural, fuel- and country-specific (traditional wood, improved biomass, coal, dung and gas/electric stoves) 24-hour HAP-PM2.5 kitchen concentrations and male, female and child exposures for 106 countries in Asia, Africa and Latin America. Results: A model incorporating fuel/stove type, urban/rural location and the socio-demographic index resulted in a Bayesian R<sup>2</sup> of 0.57. Estimated global average 24-hour HAP-PM2.5 concentrations in rural kitchens using traditional, improved biomass, animal dung, and coal stoves were 320  $\mu\text{g}/\text{m}^3$ , 180  $\mu\text{g}/\text{m}^3$ , 1,760  $\mu\text{g}/\text{m}^3$  and 400  $\mu\text{g}/\text{m}^3$ , respectively, higher than in rural kitchens using gas/electricity. Modeled female exposures from traditional wood stoves varied from 90-260 across countries, on average, with urban area exposures 40  $\mu\text{g}/\text{m}^3$  less than those in rural areas. Male and child rural area exposures from traditional wood stoves ranged from 60-190 and 80-230  $\mu\text{g}/\text{m}^3$ , respectively; urban area exposures were 10  $\mu\text{g}/\text{m}^3$  less than rural area exposures, among both sub-groups. Conclusions: A global exposure model incorporating type of fuel-stove combinations adds specificity and reduces exposure misclassification for estimation of HAP risk.

## **002.01.19. Predicting Indoor Fine Particulate Matter in the Apartments of Pregnant Women in Ulaanbaatar, Mongolia**

Weiran Yuchi

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**Abstract:** Background: Indoor and outdoor exposures to fine particulate matter (PM<sub>2.5</sub>) are both leading risk factors for death and disease, but collecting indoor measurements is often infeasible for large study populations. Methods: We developed models to predict indoor PM<sub>2.5</sub> concentrations for pregnant women who were part of a randomized controlled trial of portable HEPA filter air cleaners in Ulaanbaatar, Mongolia. We used multiple linear regression (MLR) and random forest regression (RFR) to model indoor PM<sub>2.5</sub> concentrations with 447 independent 7-day PM<sub>2.5</sub> measurements and 87 potential predictor variables obtained from outdoor monitoring data, questionnaires, home assessments, and geographic data sets. Models were evaluated in a 10-fold cross-validation. Results: The predictors in the MLR model were season, outdoor PM<sub>2.5</sub> concentration, the number of air cleaners deployed, and the density of gers (traditional felt-lined yurts) surrounding the apartments. The RFR had a higher model-based R<sup>2</sup> (93.8%) than the MLR model (52.4%), but both models had similar performance in cross-validation (R<sup>2</sup> = 48.9% for RFR vs. 50.2% for MLR). Intervention status alone explained only 6.0% of the variation in indoor PM<sub>2.5</sub> concentrations. Conclusions: We predicted a moderate amount of variation in indoor PM<sub>2.5</sub> concentrations using easily obtained predictor variables and the models explained substantially more variation than intervention status alone. While RFR shows promise for modeling indoor concentrations, our results highlight the importance of out-of-sample validation when evaluating model performance.

## **O02.01.20. Leveraging Real-Time Data to Identify Determinants of Indoor PM2.5 Exposure Disparities at the Community-Level**

MyDzung Chu

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**Abstract:** Elucidating determinants of increased indoor exposures is critical to alleviating exposure and health disparities. PM2.5 is a key determinant of indoor air quality and cardiorespiratory health. As part of the Center for Research on Environmental & Social Stressors in Housing across the Life Course (CRESSH), we investigated indoor PM2.5 sources within small spatial and temporal scales. We recruited 72 households in Chelsea, MA from 6/2016-8/2017. We collected in-home and outdoor PM2.5, housing, and activity data across 1 week for 2 seasons using a real-time sensor platform, visual assessments, and surveys. We assessed predictors of indoor PM2.5 by season using linear mixed-effect models accounting for non-linear effects of time and outdoor PM2.5, race/ethnicity, rent status, housing type, occupancy, and kitchen vent use. Households were predominantly Hispanic/Latino (49%), renters (54%), & low-income (<\$50K) (54%). Mean indoor PM2.5 was 10.3 $\mu\text{g}/\text{m}^3$  (SD: 60.2) for summer and 9.6 $\mu\text{g}/\text{m}^3$  (30.2) for winter. Across seasons, significant predictors were time of day ( $\beta=1.16-2.18$ ,  $p<0.01$ ) & outdoor PM2.5, which was more strongly associated in summer ( $\beta\geq 1.43$ ,  $p<0.02$ ). In summer, use of gas stoves (vs. electric) ( $\beta=2.05$ ) & having visitors who smoked ( $\beta=4.55$ ) were also significant ( $p<0.04$ ). In winter, any weekend cooking ( $\beta\geq 3.23$ ), residential smoking ( $\beta=2.72$ ), & weekday status ( $\beta=1.07$ ) were also significant ( $p<0.02$ ). Risk factors varied socio-demographically: renters were more likely to smoke (8.5x), homeowners more often had gas stoves (1.3x), & low-income households cooked longer periods ( $\geq 60$  min.: 1.72x). Our findings underscore the value of real-time data to identify time-varying sources and contributors of indoor PM2.5. Seasonal effects are likely driven by changes in meteorology, housing conditions, and activity that affect air exchange. The socioeconomic patterning of risk factors, much of which is modifiable, implicate targets for reducing exposure and health disparities.

## O02.01E. Understanding Early Life Exposures and Nutritional Health through the Exposome

### O02.01.21. Child Molecular Signatures of the Early Life Exposome in HELIX

Mariona Bustamante

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**Abstract:** Background: The exposome encompasses the totality of environmental exposures from conception onwards. The Human Early Life Exposome (HELIX) project offers a unique opportunity to explore the interplay between the early-life exposome and the molecular responses in childhood. Method: HELIX consists of 1,300 children aged 6-11 years from 6 European cohorts (BIB in UK, EDEN in France, KANC in Lithuania, INMA in Spain, MOBA in Norway, and RHEA in Greece). The child's prenatal and early life exposome included >200 variables: Air pollution, build environment, noise, cotinine, metals, POPs, PFAS, phthalates, phenols, and organophosphates, and life-style factors (socio-economic capital, diet and physical activity). Cross-sectional molecular measurements were obtained, including blood DNA methylation, gene and miRNA transcription, serum and urinary metabolites and plasma proteins. The exposome was related to the molecular marks through linear regression models. Results: During the prenatal period, exposure to tobacco (maternal active smoking, urinary cotinine and cadmium) was associated with DNA methylation at age 6-11 years. Moreover, maternal levels of essential metals and elements (i.e. zinc) were also associated with DNA methylation. During the postnatal period, child PFAS, mercury, arsenic and selenium were associated with metabolites derived from fish intake (i.e. polyunsaturated fatty acids (PUFA)); and child organophosphate pesticides were associated with urine metabolites related to fruit consumption (i.e. proline betaine). Further associations were found with copper and persistent pollutants across several omics suggesting a link to systemic inflammation and adiposity. Conclusion: While main associations of the prenatal exposome were with childhood DNA methylation, cross-sectional exposures were more related to metabolic profiles and proteins. Molecular biomarkers informed about source of exposure (i.e. fish) and about molecular mechanisms (i.e. inflammation).

## 002.01.22. The Early Life Exposome: Associations with Child Lipid Profile

Leda Chatzi

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**Abstract:** Background: High cholesterol levels during childhood have been associated with increased risk of atherosclerosis later in life. Apart from traditional risk factors for dyslipidemia, such as high fat diet and obesity, the contribution of environmental exposures on variations in lipid levels in childhood, is unclear. Aim: To assess the impact of a wide array of environmental exposures during pregnancy and childhood on lipid profiles in children using an exposome-wide approach. Methods: Within the HELIX exposome project, we measured over 90 prenatal and 110 childhood environmental exposures in 1,301 mother-child pairs from 6 European countries. We also measured in 2-hour fasting plasma samples, total (TC), high-density (HDL), low-density (LDL) lipoprotein cholesterol, and triglyceride (TG) levels at the age of 6-11 years. Associations were assessed using agnostic exposome-wide analyses (ExWAS) correcting for multiple comparisons. Results: Childhood exposure to organochlorine compounds was associated with increased lipids. Exposure to hexachlorobenzene (HCB) was associated with higher TC, LDL and TG levels (mean change per IQR increase: 6.6 mg/dL, 95% CI: 4.4 to 8.8; 5.7 mg/dL, 95% CI: 3.6 to 7.8 and 6.0 mg/dl, 95% CI: 2.6 to 9.4 respectively) after multiple testing correction. Dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) childhood levels were also associated with increased TGs (6.9 mg/dl, 95% CI: 3.4 to 10.4 and 9.6 mg/dl, 95% CI: 5.4 to 13.9 respectively). Childhood exposure to polybrominated diphenyl ether (PBDE 153) was associated with a 5.2 mg/dL change in TC (95% CI: 2.6 to 7.8), while copper exposure was associated with a -1.7 mg/dL change in HDL (95% CI: -2.7 to -0.8) and a 3.3 mg/dL change in LDL (95% CI: 1.5 to 5.1). Conclusions: Children with higher exposure to organochlorine compounds and copper had higher levels of lipids. Further work is needed to examine the underlying mechanisms and to exclude the role of reverse causation.

## **O02.01.23. An Exposome-Based Approach to Environmental and Nutritional Impacts of Food on Human Health**

Olivier Jolliet

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**Abstract:** Development of sustainable products requires comparing direct impacts on the user and indirect impacts such as environmental pollution in a consistent exposome-based approach. We currently lack tools that can comparably quantify environmental impacts and nutritional health effects at the food level. Here, we evaluate and compare impacts associated with foods, accounting for nutrition, particulate matter (PM) from food production, and chemical migration from food packaging. We test this approach on a pizza case study. We quantify the Dietary Risk Factors (DRF) as the disease, gender and age-specific health burden attributable to a g of 15 risk components identified to pose risk on health according to the Global Burden of Diseases, expressed in disability adjusted life years (DALYs/g). We multiply DRFs with the corresponding component densities (grisk/servingfood) for 6000+ foods, to yield the Health Nutritional Index (HENI) measured in DALYs per serving. We evaluate in parallel exposures (intake fractions) associated with ammonia emissions during food production and chemicals migrating from food packaging and use dose-responses and severity factors to evaluate their impacts in DALYs. DRFs range from -57  $\mu$ DALY/gomega-3 to 8  $\mu$ DALY/g sodium, with ischemic heart disease dominating the burden associated with most risks. HENI scores for 68 pizzas range from -3 to 36  $\mu$ DALY/serving (median: 17  $\mu$ DALY/serving), with meat pizzas having the highest impacts and vegetarian or fruit pizzas the lowest. The corresponding PM impacts are substantially lower with a median of 0.15  $\mu$ DALY/serving. Environmental impacts are strongly correlated with nutritional impacts, signifying that unhealthy foods also have the highest environmental impacts and vice-versa ( $r_{CO2}=0.69$ ,  $r_{PM2.5}=0.77$ ). For food contact material, the product intake fraction (PiF) typically ranges from  $1E-4$  to 0.8 and when combined with effect data it can yield impact estimates in  $\mu$ DALY/serving.

## 002.01.24. Environmental Exposures and Childhood Obesity: An Exposome Analysis

Martine Vrijheid

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**Abstract:** Background With an increasing number of suspected developmental obesogens, there is a need to identify those most relevant for childhood obesity risk. Objective To systematically test associations between many environmental exposures and obesity and adiposity in children, using an exposome approach. Methods The HELIX study measured obesity outcomes in 1,301 children from 6 European countries, aged 6-11 years, including age-and-sex specific SD-scores for body mass index (zBMI), waist circumference, skinfold thickness, and body fat mass. HELIX estimated over 90 prenatal and over 110 childhood environmental exposures to outdoor, chemical and lifestyle factors. Exposome-outcome associations were tested using agnostic exposure-wide analyses (ExWAS) and with the deletion-substitution-addition (DSA) algorithm that considers all exposures simultaneously. Results For prenatal exposures, maternal smoking-related variables (active and passive smoking, cotinine and cadmium concentrations) were associated with higher child zBMI in the ExWAS, although these associations did not pass the multiple testing corrected p-value (0.001). Maternal passive and active smoking during pregnancy were also selected in the DSA model. For childhood exposures, 18 exposures were associated with zBMI in the ExWAS after multiple testing correction ( $p < 0.0006$ ). In the DSA model, exposure to indoor particulate matter and copper were associated with increased zBMI, and HCB and PBDE-153 with decreased zBMI. Other adiposity outcomes showed similar results. Conclusions Early life exposure to several pollutants is associated with childhood obesity, with smoking and indoor air pollutants raising particular concern. Results for childhood exposures may suffer from reverse causation bias. The exposome's systematic approach can be used to prioritize factors for further investigation and intervention, and avoids problems of selective reporting, co-exposure confounding, and false positive results.

## **O02.01.25. Ethical Considerations Related to Studies of the Exposome**

Susan Pinney

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Abstract: The exposome encompasses the totality of human environmental exposures from conception onwards, complementing the genome. The concept was first proposed in 2005 by Christopher Wild in an article entitled "Complementing the genome with an 'exposome': The outstanding challenge of environmental exposure measurement in molecular epidemiology". The idea of the exposome was first proposed during a time of great attention to the genome, and refocused attention on environmental exposure data for casual research. In studying the exposome, there are both technical and ethical challenges. What is the current state of research methods for studying the exposome? What is our level of precision in characterizing the exposome (beneficence - maximize possible benefits and minimize possible harms)? Have these methods been validated? Are there ways to assess whether statistical methods for studying exposure mixtures yield valid results? Do we have sufficient confidence in the methods to communicate the results to the general public (beneficence)? With very complex analytical methods, and considering multiple environmental and lifestyle risk factors simultaneously, how do we communicate risk to the general public (comprehension - present the information at the study subject's level of understanding)? When returning individual exposure information (from environmental sampling or biomarkers), how many exposures are reasonable to include (respect for autonomy)? Among participants who were minor children at the time the data and biospecimens were collected and are now adults, should they be consented as adults before receiving individual exposure information? What level of responsibility does the environmental epidemiologist have to move research findings into public health action? And how?

## S02.01A. Challenges of Assessing Non-Tailpipe Emissions for Urban Air Quality and Health

### S02.01.01. Dust in the Wind: The Changing Nature of Traffic-Related Air Pollution

Greg Evans

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Abstract: Traffic has a substantial impact on air pollution in many cities. As the introduction of new vehicle technologies reduces emissions of some pollutants, the role of non-tailpipe emissions is increasing in prominence. The impact of non-tailpipe emissions has been investigated using 18 months of data collected at two near road monitoring sites in Toronto, one beside a downtown arterial road and the other beside highway 401 within the busiest stretch of highway in North America. These data indicate that non-tailpipe emissions can have large impacts on the concentrations of selected metals. Hourly and 24-h integrated measurements have revealed diurnal, weekday/weekend, seasonal and meteorology dependent patterns that help to isolate traffic-related metal sources and provide insight into the relative importance of direct emissions and resuspension of road dust. Positive matrix factorization has been applied to isolate traffic-related factors and the contribution of non-tailpipe emissions to ambient PM<sub>2.5</sub>. The oxidative potential and metal concentrations in dust samples collected at sites across Toronto are being used to evaluate the relative hazard posed by these vehicle emissions. Overall, this talk will summarize what is known about the sources, composition, and size of the different non-tailpipe particulate emission components and highlight markers of these sources that can be used for future source apportionment and modeling efforts.

## **S02.01.02. Toxicity of Non-Tailpipe Emission**

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Abstract: There is substantial evidence that exposure to airborne particulate matter (PM) from road traffic is associated with adverse health outcomes. Therefore, many efforts have been taken to diminish traffic emissions, which have resulted in a considerable reduction of tailpipe emissions in the last decades. Although it is often assumed that negative health effects are to be caused by tailpipe emissions such as soot, other components may also contribute to detrimental effects. PM from traffic emissions is not only derived from engine combustion but consist of wear emission from the road, tires and brakes as well. The contribution of these non-exhaust emissions to PM concentrations in cities is comparable or might even be more than the tailpipe contribution. With reducing tailpipe emissions, the relative contribution of non-tailpipe emissions to particulates is increasing although the implications for health are mainly unknown. This symposium presentation will give an overview of the reported toxicity studies on non-exhaust including the possible mechanisms by which non-tailpipe emissions may exert adverse health effects, for example via the link with oxidative potential.

### **S02.01.03. Modeling Brake and Tire Wear Emissions in Regulatory Models in the United States**

Darrell Sonntag

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Abstract: MOVES and EMFAC (for California only) are the regulatory vehicle emission models used in the United States to estimate brake and tire wear emissions. The emissions estimates are then used in conjunction with air dispersion models (including AERMOD, US EPA's preferred dispersion model) to estimate PM<sub>2.5</sub> and PM<sub>10</sub> concentrations in the near-road environment. We will provide an overview of the data and methods that MOVES and EMFAC uses to estimate brake and tire emissions, including a comparison to exhaust particulate matter emissions. For example, MOVES does not account for the important differences in chemical speciation between brake, tire and exhaust particulate matter emissions. We will discuss current efforts to evaluate and improve the brake and tire emission rates in the models. We will also provide an overview of regulatory context in which the emission and air quality modeling tools are used, and the limitations of these tools for conducting exposure and epidemiology studies.

#### **S02.01.04. Characterization of Non-Tailpipe and Tailpipe Emissions in Boston: Road Work in Progress**

Joy Lawrence

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**Abstract:** Background: The design and preliminary results of a study designed to develop tools to improve assessment of exposure to traffic particles and pollutants for health effects studies, characterize direct (tailpipe and non-tailpipe) and indirect contributions, and identify parameters which influence them. Study Design: Using a mobile sampling platform equipped with coarse and fine particle matter (PM) concentrators we collect ambient ultrafine, accumulation mode and coarse particle samples near roads in the Greater Boston. We also collect PM<sub>2.5</sub> and PM<sub>10</sub> aerosolized surface road dust in situ. We collect these samples at three distance ranges (roadside, 0-50m; intermediate, 50-150m; background, 500-1000m) from 100 (Census Feature Class Code A1, A2, or busy A3 type) road sites included in this study. Sites are selected based on factors including traffic density/composition, speed limit, road conditions, traffic lights, nearby development type. Each day of sampling, we also collect continuous particle count, mass, traffic, and weather data at all 3 locations simultaneously, to assess temporal variability at sites. A subset of sites will be visited multiple times in different seasons. Preliminary Results: We have completed a small number of sites and observe enrichment factor for fine particles between 8.8 and 10.8 times ambient and the coarse particle enrichment between 74 and 91. So far, enrichment has been higher at the Roadside than background or intermediate sites. All filters had loading sufficient for XRF and EC/OC analysis. Preliminary results from road dust samples with elemental concentrations normalized to Aluminum suggest trends in both coarse and fine composition with distance from road across sites. For example, fine road dust decreases relative to Al with distance from the road for Cu, Zn, Ti, Cr, Mn, and Fe, while coarse road dust suggests similar trends for Ca, Mn, Zn, and Ti.

## **S02.01.05. Health Effects of Exposure to Non-Tailpipe PM Emissions: A Critical Review**

Gerard Hoek

*Gerard Hoek<sup>1</sup>*

*1. IRAS, University Utrecht, Utrecht, Netherlands.*

**Abstract:** Gerard Hoek **Background:** Because of the reduction of tailpipe particulate emissions in most-high income countries, the relative importance of non-tailpipe emissions of motor vehicles is increasing. Epidemiological studies have started to study non-tailpipe emissions specifically. In this presentation, I will review epidemiological studies that have specifically assessed non-tailpipe emissions, separate from exhaust emissions. **Methods:** Epidemiological studies were identified by a search in Medline. Studies assessing mortality and morbidity endpoints were eligible. We included time series, case-crossover assessing short-term effects and cohort studies assessing long-term exposures. **Results:** We identified a fairly large number of time series studies on measured elemental composition and mortality / hospital admissions, predominantly in the USA. A small number of (birth and adult) cohort studies was identified where exposure was assessed with land use regression of elemental composition, including the European ESCAPE study. In some studies, Cu, Fe or Zn in PM were associated with adverse health effects, but in other studies no association was found. In most studies that evaluated markers of tailpipe emissions such as NO<sub>2</sub> or Black carbon, the correlation with these markers was high. **Conclusions:** Epidemiological studies on short and long term exposure to non-tailpipe emissions have generally not been fully consistent. Reasons for inconsistencies across studies included limitations in exposure assessment and the challenge of separating non-tailpipe from tailpipe emissions effects.

## S02.01B. Contaminant Exposures in Indigenous Communities: Tribal Research Avenues and Health Effects

### **S02.01.06. Contaminant Exposures in Indigenous Populations: A Road to Understanding**

Judith Zelikoff

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Abstract: This introductory presentation will consider the overall toxicological perspective of growing up as a Native American person in a contaminated world. Of a total of 1,388 Superfund sites throughout the nation, nearly 25 percent of them are in Indian country. Fourteen percent of all Native Americans live within 3-mi of a Superfund site. Given their cultural traditions of hunting, fishing and growing their own food, Native Americans are at greater risk for contaminant exposure through a variety of pathways. Many of these sites are not cleaned up, though not all of those listed are still active. In cases like the Navajo, the Akwesasne Mohawk and the Quapaw Tribe, the human health impacts are known because some health professionals and scientists took enough interest to do studies in their regions. But, this knowledge is the exception rather than the rule. Many of the health impacts associated with living, working and/or playing in these areas persist through generations, as in the case of the Mohawk, as a result of exposure to endocrine disrupting chemicals. This presentation will provide a description of where we are now employing a specific example of the urban-dwelling Ramapough Lenape Tribe as presented by Ramapough Turtle Clan Chief, Vincent Mann. There is an urgent need to form trusted partnerships and community-driven Tribal health studies that can build community capacity and reduce potential contaminant exposures to an already vulnerable population. A mutual community academic perspective on how to move forward and success stories with the Ramapough, will close the presentation

## **S02.01.07. Contaminant Exposures in Indigenous Communities: Tribal Research Avenues and Health Effects**

Rae O'Leary

*Rae O'Leary<sup>1</sup>, Esther Erdei<sup>2</sup>, Marcia O'Leary<sup>1</sup>, Patricia Nez-Henderson<sup>3</sup>, Jeff Henderson<sup>3</sup>*

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- 2. University of New Mexico, Albuquerque, NM, United States.*
- 3. Black Hills Center for American Indian Health, Rapid City, SD, United States.*

**Abstract:** Intro American Indians were stripped of traditional tobacco upon first contact with settlers, forcing them to use commercial tobacco for sacred ceremonies. Colonization and exploitation of American Indians by tobacco companies contribute to the Cheyenne River Sioux Tribe's (CRST) 51% smoking rate. Methods To reduce secondhand smoke exposure in indoor public places on CRST, the Canli Coalition began advocating for a tribal smoke-free air law in 2009. By 2012, 76% of tribal members supported smoke-free air in public. In 2015, the CRST became the third tribe in America to pass a comprehensive smoke-free air policy. Evidence supporting such policies will pave the way for more smoke-free policies in Indigenous territories. The CRST Mercury in the Water Study sought to find exposures to metals through fishing, smoking and land use pathways. Commercial tobacco contributes to heavy metal exposure and poor health outcomes through metal toxicants. Tobacco use and secondhand smoke exposure was collected using a survey and cotinine levels confirmed nicotine exposure. 225 adult CRST members participated from 2014-2016 (75 per year). This analysis focuses on tobacco exposure changes after the 2015 CRST Ordinance 77 was passed. Results The year following Ordinance 77, the rate of smokers with high cotinine levels (> 15 ng/ml serum cotinine concentration) was reduced from 83% to 40%. Non-smokers with high cotinine levels reduced from 18% to 13% in the year following policy adoption. The number of cigarettes smoked among current smokers did not change significantly. However, participants with intermediate cotinine levels increased in 2016 for smokers and non-smokers. Detailed home and indoor sampling for nicotine surface deposition and toxicant exposure can be included in future Tribal research agendas to accurately depict the impact of smoke-free air policies in Indigenous communities.

## **S02.01.08. Cadmium and Mercury Exposure among Dene/Métis Communities of the Northwest Territories, Canada**

Brian Laird

*Mylene Ratelle<sup>1</sup>, Leicester Fung<sup>1</sup>, Matthew Laird<sup>1</sup>, Brian Laird<sup>1</sup>*

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Abstract: In northern Indigenous communities, eating traditional foods (which include locally harvested wild game, fish, game birds, and plants) is associated with improved nutritional status. However, traditional foods can occasionally increase human exposures to contaminants. To mitigate potential risks from elevated contaminant levels in fish and wildlife, public health officials regularly respond to the results from environmental monitoring programs by designing notices that advise individuals to limit their consumption of particular traditional foods. For example, elevated mercury (Hg) levels in Walleye, Northern Pike, and Lake Trout in some subarctic lakes led to the release of a series of consumption notices by the Government of the Northwest Territories Department of Health and Social Services. Also, high levels of cadmium (Cd) in the organs of moose from the Southern Mackenzie Mountains, Canada resulted in consumption notices recommending people to limit their consumption of kidney and liver of moose harvested from this region. Since 2016, a community-based human biomonitoring project has been run in nine Dene/Métis communities of the Dehcho and Sahtú regions of the Northwest Territories Mackenzie Valley (n=538). This project included dietary assessments (e.g., 24-hour Recall, Food Frequency Questionnaire) as well as hair, urine and blood sampling to characterize contaminant exposures among participants. Although Hg and Cd levels in traditional foods from the Northwest Territories are occasionally elevated, the results from this biomonitoring research show exposures to these metals to be generally similar to those observed in other populations in Canada. These results are supporting ongoing efforts at the community and territorial level to design follow up plans in response to environmental monitoring data.

## **S02.01.09. Mercury and Other Toxicants from Mine Waste and Immune System Health Effects: The Cheyenne River Sioux Tribe's Concerns**

Esther Erdei

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*2. Missouri Breaks Industries Research Inc., Eagle Butte, SD, United States.*

Abstract: Over 900 silver and gold mines were in operation in the Black Hills area of South Dakota for almost 100 years. Extraction released mercury to the environment and it is up-taken by various fresh water fish. Fishing is vital part of Lakota life that supports subsistence and provides recreation along the Cheyenne River. CRST communities sought academic partnership as early as 2000 trying to address concerns of immunotoxicity associated with metals originated from the drinking water. Our team recruited 225 adults (53% males, 47% females; mean age: 42.9 years (range: 18-77 yrs) regularly fish along CRST waters. Hg considered ubiquitous on the land and arsenic exposures were also estimated via fishing survey. Smoking and various land use activities were assessed using questionnaires. Blood and urine samples were collected for biomonitoring. Indirect immunofluorescence and in-house ELISA techniques were used for serum autoimmunity marker determinations and multiplexing assays were applied to determine serum cytokines and immunoglobulins, components of the human immune response. Percentages of blood lymphocytes were also measured by flow cytometry. Serum cotinine concentrations validated self-reported smoking. Multivariate statistical modeling ascertained that current cigarette smoking and fish consumption were significant predictor variables of increased cytokine productions resulting in an activation of cellular and mucosal immune reactivity (GM-CSF,  $p=0.015$ ; IL-2,  $p=0.008$ ; IL-8,  $p=0.049$ ). Increased prevalence of antinuclear autoimmunity (36% ANA positivity, score >2+) was identified compared to the US national average (13.8%) and showed negative associations with serum cotinine concentrations. These results suggest that environmental toxicants can have complex, both pro- and anti-inflammatory influence. Immune response inhibition via toxicant exposures might play crucial role in chronic disease development in exposed Indigenous communities.

**S02.01.10. The Namaus (All Things Fish) Project: Community-Engaged Environmental Health Research in Collaboration with the Narragansett Tribe in Charlestown, RI, U.S.A.**

Marcella Thompson

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Abstract: For scientific knowledge to be useful, it has to be translated, synthesized, exchanged and applied within specific social, institutional and human constructs. There is none more challenging for non-Indigenous researchers than translating research to practice and policy within the context of an Indigenous knowledge framework. The Namaus (All Things Fish) Project team ensures the integration of scientific knowledge with the cultural knowledge of the Narragansett tribal community by nurturing a long-term mutually beneficial partnership based on trust and mutual respect. Conducting community-engaged environmental health research and incorporating community-based activities builds the capacity of the Narragansett Tribal government and its members for informed decision-making and participation in Tribal environmental health policy and regulatory formulation.

S02.01C. Critical Exposure Windows, Selection Biases and Novel Methods:  
Methodological Complexities in Reproductive Environmental Epidemiology

**S02.01.11. Potential for Bias when Estimating Critical Windows for Air Pollution in Children's Health**

Ander Wilson

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**Abstract:** Evidence supports an association between maternal exposure to air pollution during pregnancy and children's health outcomes. Recent interest has focused on identifying critical windows of vulnerability. An analysis based on a distributed lag model (DLM) can yield estimates of a critical window that are different from those from an analysis that regresses the outcome on each of the 3 trimester-average exposures (TAEs). Using a simulation study, we assessed bias in estimates of critical windows obtained using 3 regression approaches: 1) 3 separate models to estimate the association with each of the 3 TAEs; 2) a single model to jointly estimate the association between the outcome and all 3 TAEs; and 3) a DLM. We used weekly fine-particulate-matter exposure data for 238 births in a birth cohort in and around Boston, Massachusetts, and a simulated outcome and time-varying exposure effect. Estimates using separate models for each TAE were biased and identified incorrect windows. This bias arose from seasonal trends in particulate matter that induced correlation between TAEs. Including all TAEs in a single model reduced bias. DLM produced unbiased estimates and added flexibility to identify windows. Analysis of body mass index z score and fat mass in the same cohort highlighted inconsistent estimates from the 3 methods.

## **S02.01.12. Bias from Conditioning on Live Birth in Pregnancy Cohorts: An Illustration Based on Neurodevelopment in Children after Prenatal Exposure to Organic Pollutants**

Zeyan Liew

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Abstract: Only 60-70% of fertilized eggs may result in a live birth and very early fetal loss mainly goes unnoticed. Outcomes that can only be ascertained in live born children will be missing for those who do not survive till birth. We illustrated a common bias structure (leading to 'live-birth bias') that arises from studying the effects of prenatal exposure to environmental factors on long-term health outcomes among live births only in pregnancy cohorts. We used prenatal exposure to perfluoroalkyl substances (PFAS) and the risk of attention-deficit/hyperactivity disorder (ADHD) in school-aged children as an example. PFAS are persistent organic pollutants that may impact human fecundity and be toxic for neurodevelopment. We simulated several scenarios based on characteristics from the Danish National Birth Cohort (DNBC), and we found that a weak inverse-association may appear even if PFAS do not cause ADHD but have a considerable effect on fetal survival. Our example highlights the need for knowing the determinants of pregnancy loss and the importance of quantifying bias arising from conditioning on live birth in observational studies.

### **S02.01.13. Live Birth Bias May Affect Associations between Air Pollution and Autism**

Raanan Raz

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Abstract: In a recent publication of ours, we implemented a distributed lag model with autism spectrum disorders (ASD) data and NO<sub>2</sub> models from Israel that are highly resolved in time and space. When mutually adjusted, postnatal exposures had positive associations, while prenatal exposures had negative peak around the end of the 1st trimester. We suggest two possibilities in which the apparently protective associations could be the result of live-birth bias. The first possibility results from selection that affects the distribution of exposures in the analyzed sample. Selecting on live births may result in a group less likely to have co-exposure to both high air pollution and other causes of ASD that also affect the likelihood of live birth. In the analyzed sample, those with high exposure are less likely to have other causes of ASD (and thus a lower ASD prevalence) compared with those with lower exposure. This scenario will be described in a directed acyclic graph demonstrating conditioning over a collider. In order for the bias to act, only two assumptions need to hold: (a) air pollution during pregnancy affects the chance of a live birth; and (b) another variable (U) exists that affects both the chance of a live birth and ASD. The second possibility is that air pollution selects into the analyzed sample (live-born children) fetuses that are less susceptible to developing ASD later on. For a paradoxical protective association to arise with an exposure like air pollution, the key factor is that air pollution must lead to fetal loss preferentially among fetuses who are more susceptible to ASD (because of any other factor, e.g. genetic factors). In this case, the proportion of susceptible fetuses selected into the analysis sample (live-born children that survive to the age of ASD diagnosis) will vary across air pollution levels, with lower relative proportion of susceptible fetuses at higher exposures.

## **S02.01.14. Seeing the Invisible: A Novel Epidemiological Approach**

Marc Weisskopf

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Abstract: When all events of an outcome cannot be counted, there is risk that bias can be introduced to analyses, or even difficulty conducting basic analyses. An example is pregnancy loss, because many of these events never come to medical attention, and some may not even be recognized by the mother. This greatly limits the research that can be done into risk factors for pregnancy loss. We describe here a novel approach to the epidemiologic investigation of risk factors for pregnancy loss that takes advantage of the fact that the total number of conceptions in a given period of time is the sum of live births that result from those conceptions (live birth-identified conceptions) and those that are lost. Thus, associations with pregnancy loss—even with those that go undetected—can be inferred from results of analyses of live births. Here we describe a novel inferred effects approach, its implementation, and assumptions required for causal inference. This new approach could be a powerful approach to study effects on events that have to date been hidden to epidemiologists. The study of pregnancy loss is one example where such an approach could open up new research avenues, but we anticipate that other settings may also lend themselves to such an approach.

## **S02.01.15. Traffic-Related Air Pollution and Pregnancy Loss**

Marianthi-Anna Kioumourtzoglou

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**Abstract:** Background. Traffic-related air pollution has been linked to multiple adverse pregnancy outcomes. However, few studies have examined pregnancy loss, targeting losses identified by hospital records, a large limitation as it does not capture events not reported to the medical system. Methods. We used a novel variation of the time-series design to determine the association, and identify the critical window of vulnerability, between week-to-week traffic-related air pollution and conceptions resulting in live births, using nitrogen dioxide (NO<sub>2</sub>) as a traffic emissions tracer. We used information from all live births recorded at Beth Israel Deaconess Medical Center (BIDMC) in Boston, MA (2000-2013) and all live births in Tel Aviv District, Israel (2010-2013). For exposure assessment, in Boston we used the average of 5 urban monitoring sites, while in Tel Aviv the district average of a spatio-temporal prediction model. Results: In Tel Aviv District, the strongest estimate was during the 16th gestational week; for every 10 ppb of NO<sub>2</sub> we observed a decreased rate of live births (RR=0.82; 95%CI: 0.76-0.90), using live-birth identified conceptions to infer pregnancy losses. In Boston, the strongest estimate was during the 15th gestational week; we observed a RR = 0.87 (95%CI: 0.78-0.97), among women living within 60 km from BIDMC, and RR = 0.84 (95%CI: 0.74-0.96) in week 17 among those within 20 km from BIDMC. Conclusions: Using weekly conceptions ending in a live birth rather than identified pregnancy losses, we for the first time comprehensively considered the relationship between air pollution and all pregnancy loss throughout gestation. The observed results, with remarkable similarity in two independent locations, suggest that at levels of traffic pollution experienced in Boston and Israel, higher levels are associated with pregnancy loss with strongest estimates between the 10th-20th gestational weeks.

## S02.01D. Exposures and Health Effects Related to Unconventional Oil and Gas Development

### S02.01.16. Endocrine Disrupting Activities of Unconventional Oil and Gas Operations

Christopher Kassotis

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Abstract: Unconventional oil and gas (UOG) production utilizes the high-pressure injection of more than 1,000 industry-reported chemicals across the US to unlock previously inaccessible or unprofitable oil and natural gas deposits. We have directly tested 24 of these chemicals for endocrine disrupting activity and reported antagonist activities of 21, 21, 10, 10, and 7 for the estrogen, androgen, progesterone, glucocorticoid, and thyroid receptors, respectively. We have also previously found elevated nuclear receptor antagonist activities in surface and groundwater from UOG regions in CO, WV, WY, and other areas. To assess potential reproductive and developmental health effects throughout development, we exposed female C57Bl/6 mice to an equimolar mixture of 23 commonly used UOG chemicals at 3, 30, 300, and 3,000 µg/kg/day via their drinking water from gestational day 11 through birth. Prenatal exposure to this mixture at concentrations that are environmentally relevant resulted in adverse reproductive and developmental effects in offspring, including: modulated hormone levels, apparent effects on fertility (decreased sperm count in males and altered ovarian follicle development in females), increased body weights, and altered reproductive and other organ weights. We further characterized the potential mechanisms of UOG chemical-mediated metabolic dysfunction, and demonstrated that UOG wastewater and wastewater-impacted surface water samples at environmentally relevant concentrations could promote adipocyte development in vitro via both peroxisome proliferator receptor gamma (PPARγ)-dependent and independent mechanisms. We have previously reported PPARγ-independent adipogenic activity for various ethoxylated surfactants, some of which are included in the mixture of 23 UOG chemicals utilized above, though have not identified putative PPARγ-dependent adipogenic chemicals in these samples. This work highlights the importance of evaluating health near UOG operations.

## **S02.01.17. Environmental Monitoring for Unconventional Oil and Gas Development**

Nicole Deziel

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**Abstract:** Background: Over 4 million people live within one mile of an unconventional oil and gas (UOG) well. Quantitative environmental monitoring data and models are needed to advance understanding of the complex inter-relationships between UOG activity, water and air quality, and human exposures. Methods: In a preliminary exposure study of 66 homes in Belmont County, Ohio, we measured the volatile organic compounds (VOCs) benzene, ethylbenzene, and toluene in air inside and outside homes with passive charcoal badges. We analyzed drinking water samples for 13 UOG-related VOCs, gasoline-range organics (GRO), and diesel-range organics. Using UOG well coordinates from the Ohio Department of Natural Resources, we calculated several metrics capturing residential proximity to multiple UOG wells. Results: Detection rates were low for the air samples; no associations between well proximity metrics and air VOC detection or concentrations were observed. Distance to nearest well was negatively correlated with drinking water concentrations of GRO, toluene, and certain disinfection byproducts linked with UOG wastewater. Research underway: To advance upon this work, we are formulating a model quantifying groundwater vulnerability to UOG contamination by augmenting proximity information with hydrological data. We are collecting water samples from hundreds of homes across Pennsylvania and Ohio and analyzing them for a range of inorganic and organic compounds using new analytical chemistry techniques to aid in source attribution. Conclusions: Low detection rates impeded air monitoring inferences; more sensitive techniques are needed at a greater number of homes. Our new water vulnerability model could be used to prioritize monitoring or assign exposures in epidemiologic studies. Our inter-disciplinary approach (hydrogeology, chemistry, exposure science) to UOG environmental monitoring has the potential to provide important insights into human exposure potential via the drinking water pathway.

## **S02.01.18. Gestational Exposure to Volatile Organic Compounds (VOCs) and Trace Metals in a Region of Intensive Hydraulic Fracturing for Natural Gas Exploitation**

Élyse Caron-Beaudoin

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**Abstract:** Background: The Peace River Valley (Northeastern British Columbia, Canada), located on the Montney formation, is an area of intensive hydraulic fracturing for natural gas exploitation. Hydraulic fracturing operations can release contaminants that have been associated with adverse birth outcomes. Recent studies in the United States found associations between density and proximity of natural gas wells and birth defects, small birth weight and preterm birth. However, no exposure assessment studies have been carried in Northeastern British Columbia. Objective: To evaluate exposure to benzene, toluene and a suite of trace metals in 29 Indigenous (13) and non-Indigenous (16) pregnant women from the Peace River Valley. Methods: Enrolled participants collected urine samples over five consecutive days and provided one hair sample. We measured metabolites of benzene (trans,trans muconic acid (tt-MA), S-phenylmercapturic acid (S-PMA)) and toluene (S-benzylmercapturic acid (S-BMA)) in pooled urine samples from each participant. We measured trace metals in pooled urine samples and in the two centimeters of hair closest to the scalp. Results: The median urinary tt-MA level was 3.5 times higher (182 µg/g creatinine) than that from the general Canadian population (48 µg/g creatinine); in Indigenous participants, the median level was 6 times higher (319 µg/g creatinine). Median urinary and hair levels of barium (1.52 µg/L and 4.48 µg/g of hair), aluminum (7.60 µg/L and 4.37 µg/g of hair), strontium (148.40 µg/L and 4.47 µg/g of hair), and manganese (0.49 µg/L and 0.16 µg/g of hair) were higher in participants than reference median levels established in non-occupationally exposed volunteers. Conclusion: Our results suggest elevated gestational exposure to contaminants in our study population compared to the general population. Documenting gestational exposure to environmental chemicals in this region is paramount to assessing health risks and developing exposure mitigation strategies.

## **S02.01.19. Unconventional Gas Development Activity and Severity of Preterm Birth in the Barnett Shale, TX**

Kristina Whitworth

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**Abstract:** Background: Studies of the relation between maternal residential proximity to unconventional gas development (UGD) and preterm birth (PTB) are equivocal. No study has presented specific risk estimates by UGD-phase or pregnancy trimester. Methods: We conducted a case-control study among women with singleton births in the Barnett Shale area, TX, November 30, 2010-November 29, 2012. Five controls were individually matched to each PTB case (n=13,328) on age and race/ethnicity and controls' time-at-risk was truncated to equal the matched case's gestational age. We created separate activity metrics representing two phases of UGD for wells  $\leq \frac{1}{2}$  mile of the maternal residence. The inverse distance-weighted (IDW) count of wells in the drilling phase represented the UGD-drilling metric and the IDW sum of gas produced represented the UGD-production metric. Metrics were created for each trimester and the entire pregnancy and categorized as: zero wells (ref), 1st, 2nd, and 3rd tertiles of UGD-activity. Conditional logistic regression was used to examine associations with PTB and multinomial logistic regression was used to examine associations with PTB severity, classified as extreme, very, or moderate PTB. Results: We found increased odds of PTB among women classified in the third tertiles of the UGD drilling (1.2, 1.1-1.4) and production (1.2, 1.1-1.3) metrics. Among women classified in the highest tertile of the UGD production metric, the strongest association was observed during the first trimester (1.2, 1.0-1.4). Risk estimates for the UGD-drilling metric were similar across trimesters. We noted the greatest risk for extremely PTB [third tertile ORs: UGD drilling, 2.0 (1.2, 3.2); UGD production, 1.5 (1.0-2.3)]. Conclusion: Our results suggest differences in phase- and trimester-specific association between UGD and PTB, and indicate particular risk associated with extremely PTB.

## **S02.01.20. Congenital Heart Defects and Intensity of Upstream Oil and Natural Gas Activities in Early Pregnancy**

Lisa McKenzie

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Abstract: Our previous study indicated that mothers of infants with congenital heart defects are more likely to live in dense areas of upstream oil and natural gas (O&G) activity. The potential for exposure misclassification was a major limitation of our previous study because it lacked sufficient spatial and temporal granularity to determine the variability in maternal exposures immediately before conception and during early pregnancy or between the intensity of upstream O&G activities. To address this limitation, we applied our newly developed spatial-temporal industrial activity model in a nested case-control study, of 3,324 Colorado singleton-live births between 2005 and 2011 to mothers living in a county where at least 20 O&G well started per 10,000 births between 2004 and 2011. This spatial-temporal activity model allowed us to estimate intensities of specific upstream O&G activities in the three months before conception through the first two months of gestation, the critical development window for the developing heart. Our cases were 65, 179, 38, and 187 children born with a conotruncal, tricuspid valve, pulmonary artery, or aortic valve defect, respectively. Our 2,860 controls were children without a birth defect. We found that, after adjusting for the infant's sex and mother's age, parity, ethnicity, smoking, and proximity to other air pollution sources, mothers of children born with a conotruncal, pulmonary artery, or aortic valve defect were more likely to live in areas of dense upstream O&G activity than in areas with no activity. Our results contribute to the evidence base of the potential for adverse health effects in populations living in close proximity to upstream O&G activities and provide justification for strategies to prevent or reduce exposures and improve health in these populations.

## S02.01E. Fluoride Exposure and Health Outcomes in North America

### S02.01.21. Community Water Fluoridation and Urinary Fluoride Concentrations in a National Sample of Pregnant Women in Canada

Christine Till

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**Abstract:** Background: Fluoride exposure in pregnant women who live in regions with and without community water fluoridation has not been established. Objective: To measure urinary fluoride levels during pregnancy using urinary creatinine and specific gravity (SG) as dilution correction standards. Methods: We measured maternal urinary fluoride (MUF) concentrations in spot samples collected in each trimester of pregnancy from 1566 pregnant women living in ten Canadian cities and enrolled in the "Maternal-Infant Research on Environmental Chemicals" cohort. We calculated intraclass correlation coefficients (ICCs) to assess variability in MUF concentrations across pregnancy. We estimated associations between MUF levels, tea consumption, and water fluoride concentrations as measured by water treatment plants using regression analyses. Results: Creatinine-adjusted MUF values (M ± SD; mg/L) were almost two-times higher for pregnant women living in fluoridated regions (0.86 ± 0.34) compared with non-fluoridated regions (0.46 ± 0.50; p<0.001). MUF values had modest reproducibility (ICC = 0.41) and tended to increase over the course of pregnancy. Creatinine-adjusted MUF was positively associated with municipal water fluoride level (B=0.52, 95% CI: 0.46, 0.57), accounting for 24% of the variance after controlling for covariates. Higher MUF concentration correlated with number of cups of black (r = 0.31 to 0.32, p<0.005), but not green tea (r = 0.04 to 0.06). Urinary creatinine and SG correction methods were highly correlated (r = 0.91) and interchangeable in models examining predictors of MUF. Conclusion: Community water fluoridation is a major source of fluoride exposure for pregnant women living in Canada. Urinary dilution correction with creatinine and SG are valid and interchangeable methods for pregnant women.

## S02.01.22. Fluoride Exposure during Fetal Development and Childhood IQ: The MIREC Study

Rivka Green

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**Abstract:** Background: The potential neurotoxicity of early life exposure to fluoride, which has sparked controversy about community water fluoridation, is poorly understood. Objective: To test the association between fluoride exposure during fetal development and childhood IQ in a Canadian sample of 510 mother-child pairs enrolled in the Maternal-Infant Research on Environmental Chemicals (MIREC) birth cohort; 38% received "optimal" levels of community fluoridated water. Methods: We measured three maternal urinary fluoride (MUF) concentrations during pregnancy, averaged them and adjusted them for specific gravity. Children's cognitive abilities were assessed using the Wechsler Primary and Preschool Scale of Intelligence-III at 3-4 years of age. We used multiple linear regression analyses to examine covariate-adjusted associations between MUF and IQ, and to test for interaction with child's sex. We retained the following covariates based on theoretical and statistical relevance: city, quality of child's home environment, maternal education, and race. Results: Average MUF concentrations for all women were 0.51 mg/L (+/-0.36; range=0.06-2.44); MUF concentrations were lower in women supplied with non-fluoridated water (0.40 mg/L +/-0.27) than women supplied with fluoridated water (0.69 mg/L +/-0.41). MUF levels were inversely associated with Full Scale IQ in males (B=-4.51, 95% CI: -8.39, -0.63, p=0.02), but not in females (B=2.43, p=0.33). Among males, higher MUF levels were associated with a significantly larger reduction in Performance IQ (B=-4.63, p=0.04) than Verbal IQ (B=-2.85, p=0.14). Sensitivity analyses using MUF adjusted for creatinine and controlling for other known neurotoxins (i.e., lead, mercury and arsenic) did not substantially change the results. Conclusion: An increase of 1mg/L of MUF during prenatal development was associated with a decrease of Full Scale IQ by 4.5 points in young boys.

### **S02.01.23. Prenatal Fluoride Exposure and Cognitive Outcomes in Children at 4 and 6-12 Years of Age in Mexico**

Howard Hu

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**Abstract:** Background: Some evidence suggests that fluoride may be neurotoxic to children. Few of the epidemiologic studies have been longitudinal, had individual measures of fluoride exposure, addressed the impact of prenatal exposures or involved more than 100 participants. Objective: To discuss our recently published as well as key unpublished results of the association of prenatal exposure to fluoride with offspring measures of intelligence. Methods: We studied participants from the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) project. An ion-selective electrode technique was used to measure fluoride in archived urine samples taken from mothers during pregnancy and from their children when 6-12 years of age, adjusted for urinary creatinine and specific gravity, respectively. Child intelligence was measured by the General Cognitive Index (GCI) of the McCarthy Scales of Children's Abilities at age 4 and full scale intelligence quotient (IQ) from the Wechsler Abbreviated Scale of Intelligence (WASI) at age 6-12 years. Results: We had complete data on 299 mother-child pairs, of whom 287 and 211 had data for the GCI and IQ analyses, respectively. Mean (SD) values for urinary fluoride in all of the mothers (n=299) and children with available urine samples (n=211) were 0.90 (0.35) mg/L and 0.82 (0.38) mg/L, respectively. In multivariate models, an increase in maternal urine fluoride of 0.5mg/L (approximately the IQR) predicted 3.15 (95% CI -5.42, -0.87) and 2.50 (95% CI -4.12, -0.59) lower offspring GCI and IQ scores, respectively. Trimester-specific results suggest that exposure during the 1st trimester may have the strongest negative effect. Conclusion: In this study, prenatal fluoride exposure, in the range of exposures reported for other general population samples of pregnant women and non-pregnant adults, was associated with lower scores on tests of cognitive function in the offspring at age 4 and 6-12 years.

## **S02.01.24. Fluoride Exposure and Thyroid Function among Iodine Deficient Adults in Canada**

Ashley Malin

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**Abstract:** Background: Fluoride exposure has the potential to disrupt thyroid functioning, though adequate iodine intake may mitigate this effect. This study is the first population-based study to examine the impact of chronic low-level fluoride exposure on thyroid function, while considering iodine status. Objective: This study used weighted population-based data from Cycle 3 (2012-2013) of the Canadian Health Measures Survey (CMHS), a cross-sectional survey designed to collect health and wellness data and biological specimens on Canadians. Methods: The weighted sample represented 7,543,966 adults aged 18-79 who were not taking any thyroid-related medication. Urinary fluoride concentrations were measured in spot samples using an ion selective electrode and adjusted for specific gravity (UFSG) and creatinine (UFCR). Serum TSH levels provided a measure of thyroid function. Multivariable regression analyses examined the relationship between adjusted levels of urinary fluoride and TSH, controlling for covariates. We tested whether TSH levels were more strongly related to urinary fluoride levels in adults who were moderately-to-severely iodine deficient than in adults who were iodine sufficient, according to World Health Organization reference standards Results: The mean (SD) age of the sample was 46.6 (15.8) years and approximately 17.8% fell in the moderately-to-severely iodine deficient range. Median UFSG and UFCR concentrations were 0.74 mg/L and 0.46 mg/g, respectively. Among iodine deficient adults, a 1 mg/L increase in UFSG was associated with a 0.36 mIU/L increase in TSH [95% CI: -0.03, 0.75;  $p = 0.03$ ], and a 1 mg/g increase in UFCR was associated with a 0.61 mIU/L increase in TSH [95% CI: 0.22, 0.99;  $p < 0.01$ ]. Conclusion: Adults living in Canada who have moderate-to-severe iodine deficiencies and higher levels of urinary fluoride may be at an increased risk for underactive thyroid gland activity.

## **S02.01.25. Fluoride Exposure and Dental Enamel Fluorosis**

E. Martinez-Mier

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Abstract: At appropriate levels, fluoride has been established as an effective agent in the prevention of dental caries. However, a worldwide increasing prevalence of dental enamel fluorosis, a condition that results from excessive intake of fluoride during tooth development, has raised questions regarding a possible excessive intake of and exposure to fluoride in children. This presentation will review selected studies on the prevalence of dental fluorosis in Mexico. Results from studies conducted in naturally fluoridated areas where water content is above optimal, as well as studies conducted in areas where water has negligible, unknown or optimal amounts of fluoride and fluoridated salt is distributed, will be presented. In addition, results from studies on fluoride intake and exposure in Mexico will be discussed. Findings from a recent epidemiological study that assessed dental enamel fluorosis clinically and through the use of imaging technology as well as fluoride intake and exposure in Mexican children will be presented. Finally, trends on the prevalence of enamel fluorosis in Mexico over the last four decades (before and after the introduction of salt fluoridation) will be discussed. The presentation and discussion of this evidence will be useful to inform public policy aiming at optimizing the beneficial effects of fluoride while minimizing its detrimental effects.

## S02.01F. Healthy Climate Solutions: What is the Evidence for Health Benefits of Climate Change Mitigation Strategies?

### **S02.01.26. Introduction and Overview of Health Benefits of Urban Climate Mitigation Strategies**

Patrick Kinney

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Abstract: Research has demonstrated a broad range of adverse health impacts that are exacerbated by climate change. Attention has lately turned to the health aspects of climate solutions, including adaptation strategies to avert the worst consequences of rapid climate changes that are already underway, as well as assessments of the health benefits and/or impacts of mitigation actions aimed at reducing human influence on the climate system. For example, the global Healthy-Polis consortium, launched in 2013, is a global network focused on protecting and promoting urban health through multi-disciplinary, policy-relevant research on urban environmental health and sustainability. Climate change mitigation plans are reducing emissions of climate-damaging pollutants such as CO<sub>2</sub>, methane, and black carbon through strategies such as energy efficiency, increased use of renewables, reduced automobile dependency, urban greening, and others. While designed to achieve long-term carbon emission reduction goals, these mitigation strategies have the potential to achieve local public health benefits that accrue in the near term, both in space and time. Here I provide an overview and introduction to health benefit assessments for interventions related to mobility, buildings, and green space.

## **S02.01.27. Clean Transportation Interventions in Cities**

Mark Nieuwenhuijsen

*Mark Nieuwenhuijsen<sup>1</sup>, Natalie Mueller<sup>1</sup>, David Rojas-Rueda<sup>1</sup>*

*1. ISGlobal, Barcelona, Spain.*

**Abstract:** Background and aims: Research over recent years has convincingly demonstrated a broad range of adverse health impacts that are exacerbated by climate change. Climate change mitigation involves reducing emissions of climate-damaging pollutants such as CO<sub>2</sub>, methane, and black carbon through strategies such as energy efficiency, increased use of renewables, reduced automobile dependency, urban greening, and others. The aim of this session is to present some recent examples of proposed clean transportation interventions in cities worldwide and the impact on health.

**Method:** We obtained some recent examples of proposed and implemented clean transportation interventions in cities and demonstrate the impact on health and the economy. We focus on measures to reduce car use and promote public and active transportation. The studies considered multiple environmental and behavioral risk factors (e.g. air pollution, noise, traffic incidents, physical activity, green spaces and temperature) and multiple outcomes (cases of mortality, morbidity, disability adjusted life years, and economic costs). **Results:** We will present a number of recent studies estimating the health impacts of clean transportation interventions worldwide including the reduction of car use and increase in cycling, tram and Bus Rapid Transit and changes in the urban setting. The studies compare risks and benefits of clean transport interventions. All the studies show a considerable potential beneficial impact on health mainly through the increase of physical activity. **Conclusion:** Clean transportation interventions in cities worldwide cannot only mitigate climate change but also improve public health.

## **S02.01.28. Healthy Suburbs: A Case Study**

Alistair Woodward

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Abstract: Studies of the low-carbon urban transition have tended to focus on the inner city, since this is where rapid progress can be made most readily. Low density suburbs in new, car-dominated cities have received less attention, although this is the setting in which the majority of the urban population live, in many countries. Why are these parts of the city neglected, and what prospects exist for climate mitigation with health co-benefits? I will attempt to answer these questions, with reference to early results from Te Ara Mua - Future Streets, a controlled before-after intervention study of street improvements to improve safety and increase walking and cycling. The setting is a low-income Auckland suburb with a high proportion of Maori and Pacific residents. Outcomes include physical activity, air quality, greenhouse gas emissions, injuries and social wellbeing.

## **S02.01.29. Urban and Transport Planning Related Exposures and Mortality: A Health Impact Assessment Study for Bradford, UK**

Natalie Mueller

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**Abstract:** Introduction: By 2050, almost 70% of people globally are projected to live in cities. As the environments we inhabit affect our health, urban and transport designs that promote healthy living are needed. We estimated the number of preventable premature deaths under compliance with international exposure recommendations for physical activity (PA), air pollution, noise, and access to green spaces in Bradford, UK. Methods: We applied the Urban and Transport Planning Health Impact Assessment (UTOPHIA) tool to Bradford. Exposure data of PA, air pollution, noise, and access to green spaces were available for 393,091 Bradford residents  $\geq 18$  years at the Lower Super Output Area (LSOA; N=310) level. We compared recommended with current exposure levels. We quantified the associations between exposures and mortality and calculated population attributable fractions to estimate the number of preventable premature deaths. We also modeled changes in life expectancy and economic impacts. Results: Annually 376 premature deaths (95% CI: 277-475) were estimated to be preventable under compliance with exposure levels for PA, air pollution, noise, and access to green spaces. The biggest share in preventable deaths was attributable to increases in PA (327 deaths; 95% CI: 245-441), followed by reductions in air pollution and noise and increases in access to green spaces. Compliance was estimated to increase average life expectancy by 349 days (95% CI: 210-495) and result in economic savings of almost £ 60,000 per person (95% CI: 36,028-85,087). Residents of LSOAs which are classified as more deprived and more ethnically diverse were estimated to be more adversely exposed and to die more prematurely. Conclusions: Results of HIAs of urban and transport planning related performance are important for cities (1) to identify local health hazards, (2) to better understand the associated health burden and its distribution among the population, and (3) to formulate targeted mitigation strategies.

## S02.01G. New Approaches for Environmental Health Impact Studies: Assessing Human Health Risks from Chemical and Non-Chemical Stressors

### **S02.01.31. Assessment of Human Health Risk Using a Variety of Risk Assessment Approaches**

Elizabeth Miesner

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**Abstract:** Human Health Risk Assessments (HHRAs) have been widely used for decades to quantitatively evaluate potential adverse health effects of exposures to environmental hazards. In guidance and application, HHRA has focused on the potential toxicity of the chemical component of exposure, but does not address other factors that may have public health consequences such as economic, social and planning factors. Most HHRAs do not address the combined impact of different types of exposure, which may disproportionately affect some racial, ethnic and socioeconomic groups. Both chemical and non-chemical stressors (e.g. physical [radiation, noise, vibration, temperature], biological [allergens, molds, pathogens], and social [stress, behaviors, lack of resources]) may impact the health of individuals and communities. Several alternative methods of assessing cumulative environmental stressors and health impacts on a community level have been developed including Health Impact Assessments (HIAs) and Cumulative Risk Assessments (CRAs). HIA is an emerging strategy to assess effects on non-traditional stressors on public health. It is used and promoted as an alternative or complement to HHRA. HIA also includes consideration of benefits, as well as adverse impacts. CRA is an analysis, characterization, and possible quantification of the combined risks to health or the environment from multiple agents or stressors. USEPA came out with their document "The Framework for Cumulative Risk Assessment" in 2003 as the first step in a long-term effort to develop cumulative risk assessment guidance, and it has recently been applied in multiple environmental settings. This talk describes methods to assess site-specific risks to human health, including the more traditional HHRA process, as contrasted to HIAs and CRAs and. The pros and cons of each procedure will be discussed, with an eye towards highlighting the strengths of each.

## **S02.01.32. Using Health Impact Assessments to Assess Potential Health Impacts of Local Infrastructure Projects: A Case Study**

Anushree Bhatt

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Abstract: Rapid population growth in Ontario has resulted in a need for new infrastructure, including wastewater treatment plants (WWTPs). In support of a previously completed Environmental Assessment for a proposed WWTP, a Health Impact Assessment (HIA) is currently being conducted to assess the potential positive and negative health impacts due to the project to a First Nations Community (FNC). The HIA process is complementary to existing risk assessment and environmental assessment protocols where human health is viewed, not only from the perspective of environmental exposure to chemicals in the built and natural environments, but in terms of various health determinants such as physical health, mental well-being, and social, cultural and economic factors. The ongoing HIA, while providing a platform to enhance communication and address the concerns of the FNC, will recommend measures to enhance the potential positive impacts and mitigate any negative impacts due to the project. To determine the scope of the HIA, potential health issues of concern to the FNC due to the proposed WWTP, were identified and then reviewed through discussions with the FNC, public health and municipal officials, and other stakeholders. The engagement process identified that the main health determinants to be assessed in the HIA include: surface water quality with regards to pharmaceuticals and personal care products, food security, climate change, access to drinking water, impacts to cultural values and traditions, and the social and mental wellbeing of the FNC. Although this HIA is ongoing, initial results indicate that the HIA process will play an important role in establishing an unbiased means of communication between municipalities and FNCs. In general, HIAs are not intended to be advocacy tools; rather they are intended to provide further consideration of potential health outcomes of a given project or policy.

### **S02.01.33. An Analysis of the Use of Various Health Assessments Tools in the Natural Gas and Oil Development Sector**

Uni Blake

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Abstract: The past decade saw an increase in natural gas and oil development in the United States. The increase was mainly due to an innovative use of previously utilized technology, which made it possible to access shale resources that had been considered uneconomical for development. Shale basins cover a broad expanse of regions, underlying communities that were traditionally unaccustomed to industry operations. The rate at which development activities spread across the regions, led to community concerns about potential health impacts from both chemical and nonchemical stressors. Theoretically, using alternative assessments tools, including health impact assessments (HIAs), to address the concerns is seen to have value. Not only do HIAs provide the necessary recommendations that are required to improve positive public health outcomes and minimize the adverse health outcomes of projects, HIAs foster cross-sectoral collaborations which are crucial to developing solutions with maximum stakeholder buy-in. However, the adoption of these alternative tools in the U.S. has been slow as there is varying interest in the use of assessment tools in natural gas and oil development. Using HIA's as a case study, this presentation discusses examples of where HIAs have been used in the sector and identifies some of the challenges and potential solutions.

## **S02.01.34. Methods for Modeling Exposures and Health Risks from Combined Chemical and Non-Chemical Stressors**

Jonathan Levy

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**Abstract:** Background: Although there is increasing interest in cumulative risk assessment and related approaches to characterize health impacts from multiple stressors, methodological challenges remain. Published epidemiological studies rarely report associations in a manner applicable for cumulative risk assessment, and multi-stressor exposure data are often lacking. We provide two examples that illustrate the strengths and weaknesses of novel methods for characterizing multi-stressor exposures and associated health risks. Methods: In one case, we utilized biomarker and questionnaire data from a prospective birth cohort study to develop exposure regression models that can be used to estimate exposures in a population-based surveillance database. We used generalized additive models (GAMs) to investigate the association between the predicted exposures, other stressors, and teen pregnancy. In the second case, we used sociodemographic Census information, temperature and air pollution predictions from satellite-based models, and other GIS data to characterize exposures for all Massachusetts births, and we applied elastic nets and Bayesian kernel machine regression (BKMR) to select among candidate variables and determine multi-stressor associations with birth weight. Results: Regression models explained exposure variability as a function of sociodemographics, birth address, and birth year. GAMs yielded valuable insights regarding non-linear interactions among stressors that would not have been identified through conventional approaches. While elastic net and BKMR models yielded different subsets of predictors, constrained model-building strategies helped identify the combinations of stressors associated with birth weight. Conclusions: Exposure modeling that leverages population-specific measurements and extensive GIS data, coupled with epidemiological approaches selected with cumulative risk assessments in mind, provide value insight on the health effects of combined exposures.

## **S02.01.35. The Territorialized Exposome Concept to Characterize Cumulative Risk at the Population Level**

Julien Caudeville

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**Abstract:** Risk assessors and risk managers are currently facing two realities: The need to consider the impact of multiple exposures and combined risks, and the substantial growth of environmental data production at the territory level. The exposome concept has been proposed as an emergent exposure science paradigm for conceptualizing the cumulative effects of environmental exposures across the whole human life. The need for risk manager to identify population at-risk in the context of substantial data deficiencies that hinder evaluation of cumulative health risks brings the operational declination of the concept at the territorial scale. The characterization of the territorialized exposome implies the development of dynamic, multidimensional, longitudinal approaches, and information systems that require the adoption of transdisciplinary methods of data analysis. Integrated approaches could bring together all information necessary for assessing the source-to--dose continuum using GIS, multimedia exposure and toxicokinetic model. Different approaches could be considered for screening-level analysis of spatialized cumulative risks based on toxicology data or multivariate approach to combine exposure variables at the population level. Several case studies will be presented in a tiered manner to illustrate organized data processing when the ultimate goal of cumulative risk assessment is to identify overexposed population. Review of toxicology data are conducted in order to group substances or risk factors sharing similar toxicological effect. In other cases, finding a common metric for dissimilar risks is not a strictly analytic process, because judgments must be made as how to link two or more separate scales of risks during a deliberative process, including stakeholders to identify operational actions adapted to the policy objectives.

## S02.01H. Research-To-Action Gaps: How Can We Implement Successful Programs to Reduce Exposure to Lead and Other Environmental Contaminants in Low and Middle-Income Countries?

### **S02.01.36. The Challenges of Translating Research into Action for Lead and Other Environmental Contaminants in Low and Middle-Income Countries**

Katarzyna Kordas

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Abstract: The toxic effects of lead were first described many centuries ago, yet to this day, lead continues to be a public health problem and appears as subject of scientific papers. The renewed notoriety of lead follows important recent cases of environmental injustice in the U.S., and increasingly common reporting on lead exposure and poisoning in low and middle-income countries. Arguably, few researchers, communities, or public health officials need additional convincing that lead exposure among pregnant women and young children is a public health problem. Estimates of health and economic impact of environmental or toxic-site exposure to lead for LMIC populations, particularly children, suggest substantial economic and disease burden. Some believe that more epidemiological research on the associations between lead exposure and adverse health outcomes is not only unnecessary but counter-productive because it delays action. The well-known health impacts, and the estimates of economic impacts place greater urgency on incorporating the environment more squarely into prevention efforts for a number of noncommunicable diseases. Despite an enormous amount of research produced globally, and despite clear economic impacts, many LMICs lag in terms of effective or sustained programs or policies exist to address the continuing problem of lead exposure. By 2020, LMICs will account for 33% of global chemical demand and 31% of production, a 10 percentage point increase from mid-1990s. Given the growing list of environmental contaminants of concern for child health and development, and of their increasingly documented mixture effects, the research and policy communities need to engage in conversations that will facilitate the translation of research into action. This brief presentation will lay the groundwork for the symposium by summarizing the patterns and consequences of lead exposure globally, thus underscoring the continued importance of the issue.

## **S02.01.37. Addressing Environmental Exposures through State and National Programs**

Fuyuen Yip

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Abstract: Environmental hazards found in the air, water, soil, and built environment are contributing to chronic diseases affecting health and quality of life worldwide. According to the World Health Organization, about 12.6 million deaths each year are attributable to unhealthy environments. In the US, environmental factors have been associated with many leading causes of death including: cancer, unintentional injuries, and heart, respiratory, and cerebrovascular diseases. National surveillance systems implemented by the Centers for Disease Control and Prevention (CDC) are paramount to better understanding of environmental hazards, human exposures, and relevant health effects over space and time. The Lead Contamination Control Act of 1988 authorized CDC to initiate efforts to eliminate childhood lead poisoning in the U.S. by supporting state and local agencies to develop programs for surveillance and monitoring of children's blood lead levels. Elevated blood lead levels were the first noninfectious condition to be notifiable at the national level. In 2000, The Pew Environmental Health Commission released a report on the state of environmental health in the U.S. calling for the creation of a coordinated public health system to improve response to environmental threats. The Environmental Public Health Tracking Program was formed in 2002 when Congress authorized funding to establish and develop a nationwide network of integrated health and environmental data that can inform actions to improve the health of communities. This presentation will provide a brief history and overview of two important programs addressing environmental contaminants to highlight successes and key challenges of developing these programs at the national level in collaboration with state and local agencies, Federal partners, and other stakeholders.

## **S02.01.38. The Environmental Contaminants Clinic in Montevideo, a History**

Elena Queirolo

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Abstract: In year 2000, with the now famous case of lead poisoning among children of the La Teja neighborhood, the city of Montevideo faced a serious public health problem. This presentation will first present the history of lead pollution in Uruguay, and the first political and social responses to the issue, including the creation in 2001 of the "Lead Polyclinic" at the Pereira Rossell Children's Hospital in Montevideo, which is the only University Pediatric Hospital in the country. The mission, function and impact of the Polyclinic will be presented; its professional staff, number of children attended. The Polyclinic closed after 15 years of operation, amid protests from staff and patients' families. The reasons argued for the final closure of the Polyclinic by public health authorities will be presented. Some of the functions and operations of the clinic were divided among other healthcare and laboratory facilities, but the decision to close has left many children without proper health care. The presentation will also discuss lessons learned about the exposure to lead in these 15 years and the impact it is likely to have on the health of children, most of whom come from the lower social classes. The presentation will also include opinions collected and studies conducted that analyze the phenomenon of lead pollution in Uruguay. Amongst them is the realization that the implementation of policies that resulted in the closing of the polyclinic for environmental pollutants, instead of demonstrating a state of alertness to children's environmental health and instead of interest in the continuous advance of knowledge, indicate a minimalization of the problem by decreasing human and material resources allocated to environmental issues.

## **S02.01.39. Disconnect between the Research on Lead's Effects, and Efforts to Generate a Lead Awareness and Prevention Program at a National-Level in Mexico**

Martha Téllez-Rojo

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Abstract: The documentation of lead poisoning in Mexico started at the beginning of XIX century, clearly identifying the use of traditional ceramics to prepare, store and serve food as a source of exposure. These ceramics are produced with a final layer of a lead glaze, which is ideal for the low-temperature domestic kilns. The use of these ceramics is deeply embedded in Mexican culture, but with every use in cooking or serving of food, lead leaches out. Thus, ceramic ware constitutes an important source of exposure for both the end-users and artisan-producers and their families. Much epidemiological research has been conducted by our research group to assess the toxic effects of lead exposure on a wide variety of outcomes through the ELEMENT and PROGRESS cohort studies. Our research has had an impact on lead regulation in several countries, including the U.S. and Mexico. In Mexico, the reference blood lead level for pregnant women and 0-15 year old children was 10 µg/dL until 2017, when it matched the Centers for Disease Control and Prevention (CDC) level of 5 µg/dL. Nevertheless, there is no routine surveillance program or social interventions to prevent lead exposure; furthermore, there is no public awareness of lead's toxicity. This talk will present the efforts conducted by our research group to generate supporting evidence that lead exposure is a public health problem in Mexico and should be addressed. Effects of lead exposure are subclinical, especially at low levels, and compete with other prominent health concerns such as obesity or diabetes. The strategies used by our group to generate evidence aimed at policy makers are designed in the context of scarce economic resources; therefore, lessons learned could be useful to other countries in similar situations.

## 002.02A. Advances in Ambient Air Pollution Modeling 1

### 002.02.01. A Parsimonious Approach to National Prediction: Criteria Pollutants in the Contiguous U.S., 1979 - 2015

Sun-Young Kim

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**Abstract:** **INTRODUCTION:** Many cohort studies have relied upon prediction models to estimate individual-level long-term exposure to air pollution. These models commonly include hundreds of geographic variables; however, employing a smaller subset of these variables may yield similar predictions. This study aimed to explore a parsimonious modeling approach using subsets of geographic variables to develop national exposure prediction models for six criteria pollutants during 1979-2015 for the contiguous U.S. **METHODS:** We computed annual average (1979-2015) concentrations from US EPA regulatory monitoring stations for criteria pollutants (PM10, PM2.5, NO2, SO2, CO, O3) at all available sites that met our inclusion criteria. We also computed ~350 geographic variables such as traffic, population, and land use. Then, we applied a parsimonious version of a previously-developed national prediction model. This model was constructed in a universal kriging framework including summary predictors, estimated by partial least squares (PLS) from geographic variables, and spatial correlation. For the parsimonious models, we tested three approaches using: (1) no geographic variables, (2) a limited number of variables chosen by forward selection from all as input data for PLS, and (3) all variables. We evaluated model performance using 10-fold cross-validation. **RESULTS:** Models using between 3 and 30 selected variables generally gave the best performance across pollutants and years (median R<sup>2</sup>=0.47-0.87) compared to kriging with no and all geographic variables (0.29-0.71; 0.33-0.84). NO2 and PM2.5 showed large differences between models with 3-30 vs. no variables (0.87 vs. 0.61; 0.86 vs. 0.71). SO2 and ozone had small differences among the three approaches (0.57-0.59; 0.71-0.75). **CONCLUSION:** Our findings suggest that a national prediction model built on only a small number (30 or fewer) of important geographic variables selected from the hundreds can provide robust estimates of concentrations.

**002.02.02. National PM2.5 and NO2 Spatiotemporal Models Integrating Intensive Monitoring Data and Satellite-Derived Land Use Regression in a Universal Kriging Framework in the United States: 1999-2016**

Meng Wang

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**Abstract:** Background: Recent nationwide PM2.5 and NO2 exposure models increasingly incorporate land-use regression, satellite-derived observations and spatial smoothing to improve prediction accuracy for epidemiological studies. However, those studies exclusively relied on exposure data from routine monitoring sites that could be less useful for small spatial-scale predictions. Objectives: To develop regionalized national models in estimating PM2.5 and NO2 exposures with high spatiotemporal resolution from 1999 to 2016 in the United States. Methods: We collected monitoring data from numerous regulatory (number of monitors: 1495 [PM2.5], 754 [NO2]) and cohort-specific monitors (939 [PM2.5], 2573 [NO2]) that captured fine-scale residential and roadway exposure gradients. We established a novel modeling framework that incorporated all of the unbalanced monitoring data with land use regression and universal kriging using dimension-reduced predictor variables from satellite observations and a large geographic database. Results: Ten-fold cross-validations showed good model performances with total spatiotemporal R2s of 0.82 and 0.81 for PM2.5 and NO2 using the left out routine monitors. We observed larger within-city spatial variations (coefficient of variation [CV]) from the best models that accounted for cohort-specific monitors than the models that completely relied on routine monitoring sites (increased % of CV: 20-27% for PM2.5, 23-32% for NO2). Regional spatial R2 was highest in the southeast region (0.91) for PM2.5 and lowest in the northwest region (0.71), but was generally the same for NO2 across regions (0.84-0.87). Including satellite PM2.5 or NO2 data moderately improved predictions for points far from monitoring locations. Conclusion: Our models can make accurate point predictions of PM2.5 and NO2 concentrations at both short and long time scales when utilizing additional data from a large number of fine-scale monitors and satellite technology.

### **002.02.03. National PM2.5 and NO2 Exposure Models for China Based on Land Use Regression, Satellite Measurements, and Universal Kriging**

Hao Xu

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**Abstract:** Introduction: China is the country with the largest number of air pollution deaths per year. Our research aims to improve the spatial resolution of national air pollution estimates for China. We develop and evaluate national empirical models for China incorporating land-use regression, satellite measurements, and universal kriging (UK). Methods: We employ regulatory monitoring data for PM2.5 and NO2 for 2014 and 2015, and ~300 geographic covariates, including categorized "points of interest" (i.e., gas stations, factories, bus stops etc.). Our tests of model performance include (1) forward stepwise linear regression vs. partial least squares (PLS) regression modeling, (2) with and without satellite measurements, and with and without UK, (3) 10-fold cross-validation (CV), leave-one-province-out CV (LOPO-CV), and leave-one-city-out CV (LOCO-CV). Results: UK improves models in well-sampled areas, whereas satellite data substantially improves performance at locations far from monitors. Stepwise linear regression performs similarly to PLS in 10-fold CV, but better in LOPO-CV. Our best models, with forward selection and UK, provide good predictions of ambient PM2.5 (10-fold R2: 0.89 for both 2014 and 2015) and NO2 (10-fold R2: 0.73 and 0.78 for 2014 and 2015, respectively). Population-weighted concentrations during 2014 - 2015 decreased for PM2.5 (from 59 to 52  $\mu\text{g}/\text{m}^3$ ) and NO2 (from 30 to 27  $\mu\text{g}/\text{m}^3$ ). Conclusion: We produced the first high-resolution national LUR-based models for China. Maps (1 x 1 km<sup>2</sup>) of concentrations reveal important spatial gradients in China; we will make those data publicly available online.

#### **002.02.04. Using Geostatistical Simulation to Inform the Quantity and Placement of New Monitors for a Follow-Up Air Sampling Campaign**

Jesse Berman

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Abstract: Sampling campaign design is a crucial aspect of air pollution exposure studies. Selection of both monitor numbers and locations is important for maximizing measured information, while minimizing bias and costs. We developed a two-stage geostatistical based method using pilot NO<sub>2</sub> samples from Lanzhou, China with the goal of improving sample design decision-making, including monitor numbers and spatial pattern. In the first step, we evaluate how additional monitors change prediction precision through minimized kriging variance. This was assessed in a Monte Carlo fashion by adding up to 50 new monitors to our existing sites with assigned concentrations based on conditionally simulated NO<sub>2</sub> surfaces. After identifying a number of additional sample sites, a second step evaluates their potential placement using a similar Monte Carlo scheme. Evaluations are based on both prediction precision and accuracy. Costs are also considered in the analysis. It was determined that adding 28-locations to the existing Lanzhou NO<sub>2</sub> sampling campaign captured 73.5% of the total kriged variance improvement and resulted in predictions that were on average within 10.9mg/m<sup>3</sup> of measured values, while using 56% of the potential budget. This method allows for informed sampling design by quantifying prediction improvement (accuracy and precision) against the costs of monitor deployment.

## **002.02.05. Potential Overfitting in a Spatio-Temporal Exposure Model Developed with Few Monitoring Sites**

Jia Xu

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**Abstract:** Overfitting is a concern with air pollution estimation models that rely on a limited number of monitoring sites. Here we develop spatio-temporal air pollution exposure prediction models using land use regression in a universal kriging framework with temporally rich but spatially poor monitoring data. Two-week average concentrations for six criteria pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub>, ozone and CO) from 2014 through 2017 were obtained from 23 administrative monitoring sites in the urban area in Beijing. A large array of geographic covariates (GC) was collected. Exposure prediction models for the air pollutants involved three steps: (1) deriving the smoothed temporal trends from a singular value decomposition; (2) reducing the dimensionality of the collected GC using partial least square regression (PLS); (3) developing spatio-temporal models based on the previous smoothed temporal trends and GC-related PLS scores. Leave-one-out cross validation (LOOCV) was used for prediction accuracy at each of the three steps: All steps (123), steps 2 and 3 (23), steps 1 and 3 (13), and for only step 3. The LOOCV R<sup>2</sup> (R<sup>2</sup><sub>cv</sub>) of the spatio-temporal models (step-3) were 0.86, 0.95, 0.90, 0.82, 0.94, and 0.94 for PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub>, ozone and CO, respectively. The R<sup>2</sup><sub>cv</sub> of step-123 models were 0.76, 0.91, 0.79, 0.27, 0.86 and 0.87, the R<sup>2</sup><sub>cv</sub> of step-13 models were 0.84, 0.94, 0.89, 0.78, 0.94 and 0.94, and the R<sup>2</sup><sub>cv</sub> of step-23 models were 0.76, 0.91, 0.80, 0.29, 0.84 and 0.87 for these air pollutants. Prediction accuracy of the two-week average spatio-temporal models was excellent for all of the pollutants. However, when taking into account the two steps of smoothed temporal trends (step-1) and GC-related PLS scores (step-2) before the model development, evidence of overfitting was found for the step-23 models, due to using LOOCV in obtaining PLS scores. Model performance reflects overfitting when these spatio-temporal models are developed using a limited number of monitoring sites.

## O02.02B. Ambient Air Pollution and Cardiopulmonary Morbidity and Mortality

### O02.02.06. Understanding the Effects of Ambient Air Pollutants on Morbidity in Colombia: A Multi-City & Multi-Pollutant Analysis

Laura Rodriguez-Villamizar

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**Abstract:** Objective: To estimate the short-term effect of mixtures of ambient air pollutants on respiratory and cardiovascular morbidity in four Colombian cities. Methods: Emergency department (ED) visit records for respiratory and cardiovascular selected diagnosis were obtained for the National Social Protection Information System for the cities of Bucaramanga, Bogota, Cali, and Medellin during 2011-2014. Daily concentrations for six criteria air pollutants were obtained from the National Air Quality Network. Using conditional negative binomial time series analysis with marginal effects we assessed the effect of one-pollutant, two-pollutant and specific mixtures of pollutant models controlling for meteorology and time trends. Rate ratios (RR) were calculated for the joint effect of pollutants. Results: In one-pollutant models increases in gases concentrations were associated with increases in ED visits for respiratory diseases, and increases in gases and particulate matter were associated with increases in ED visits for cardiovascular diseases. The two pollutant models for respiratory diseases showed that the effect of NO<sub>2</sub> alone (RR 1.91 95% CI 1.26-2.55) is higher than the joint effect of any of its combinations (NO<sub>2</sub>+PM<sub>2.5</sub> RR 1.88 95% CI 1.08-2.69) but lower than the effect of PM<sub>10</sub> with SO<sub>2</sub> (RR 2.14 95%CI 1.37-2.93). The two-pollutant models for cardiovascular diseases showed synergistic effects between NO<sub>2</sub> and SO<sub>2</sub> (RR 4.85 95%CI 3.75-5.95) and PM<sub>10</sub> and SO<sub>2</sub> (RR 3.6 95%CI 2.84-4.39). Specific mixtures models showed that the mixture of "oxidant gases" (NO<sub>2</sub>+O<sub>3</sub>+SO<sub>2</sub>) has the higher joint effect on cardiovascular morbidity and the mixture of "traffic-related air pollutants" (NO<sub>2</sub>+CO+PM<sub>2.5</sub>) has the higher joint effect on respiratory morbidity. Conclusions: The results show the health effect of each pollutant and the dominant effect of NO<sub>2</sub> in air pollution mixtures on respiratory and cardiovascular morbidity and the co-dominant effect of SO<sub>2</sub> in mixtures on cardiovascular morbidity.

## **O02.02.07. A Multi-Country Study on Ozone-Related Mortality**

Ana Vicedo-Cabrera

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**Abstract:** Many studies have characterized the short-term association between ozone and mortality in different settings, but mostly across limited geographical areas and using different methodological approaches. In this study, we aimed at comprehensively assessing short-term ozone-related mortality associations in a multi-country analysis. **Method:** We collected daily mortality and air pollution data (ozone, O<sub>3</sub>, and particulate matter, PM<sub>10</sub>) from 245 locations in 16 countries (Australia, Brazil, Canada, Chile, Columbia, France, Japan, South Korea, Mexico, Portugal, Spain, Sweden, Switzerland, Taiwan, Thailand, and United States), included in the Multi-City Multi-Country Collaborative Research Network. We applied a two-stage time-series design. First, we modelled mortality-ozone associations across 21 days of lag using quasi-Poisson regression and distributed lag linear models (DLMs). Second, we performed a multilevel multivariate meta-regression to obtain pooled associations across locations nested within country. Best linear unbiased predictions (BLUPs) were derived at both location and country levels. We estimated season-specific ozone-related mortality through time-varying interaction DLMs. **Results:** On average, an increase in 10 µg/m<sup>3</sup> in ozone was associated with a 0.6% increase in mortality risk [95%CI: 0.3 to 0.8%]. The positive association was lagged and persisted during the following 7 days. Country-specific BLUPs ranged between 0.2%[-0.05 to 0.5] in Brazil to 0.8%[0.5 to 1.2] in the US. The ozone-related mortality association was significantly larger in winter [0.8%, 0.5 to 1.0] vs summer [0.5%, 0.4 to 0.7]. Results were robust to sensitivity analyses, such as multi-pollutant models. **Conclusion:** This represents the largest epidemiological study on health effects of ozone. By using a common advanced statistical framework, we provide robust evidence on the association with all-cause mortality in different locations across the globe. On behalf of the MCC Network

## **O02.02.08. Short-Term Associations between Daily Mortality and Fine Particulate Matter, Nitrogen Dioxide, and the Air Quality Index in Tehran, Iran**

Heresh Amini

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**Abstract:** There is limited evidence for short-term associations between mortality and ambient air pollution in the Middle East, and no studies examining the association between daily mortality and the air quality index (AQI). We investigated short-term associations between non-accidental mortality and fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and the AQI from March 2011 through March 2014 in the megacity of Tehran, Iran. Generalized additive quasi-Poisson models were used within a distributed lag non-linear modeling framework to estimate the effects of PM<sub>2.5</sub>, NO<sub>2</sub>, and AQI from lag 0 to lag of 45 days. Positive associations were found in most models, with strong evidence of effect modification by sex, age, and season. The maximum cumulative rate ratios (95% confidence interval) per inter-quartile range increment were: 1.19 (1.12, 1.28) for NO<sub>2</sub> over the previous 45 days (for males, all ages, in cooler months); 1.14 (1.07, 1.21) for PM<sub>2.5</sub> over the previous 30 days (for females, all ages, in cooler months); and 1.15 (1.08, 1.22) for AQI over the previous 31 days (for females, all ages, in cooler months). The cumulative effects remained positive in multipollutant models. Overall, we found that the effects of PM<sub>2.5</sub>, NO<sub>2</sub>, and AQI on mortality in Tehran were immediate, and that they increased steadily over a period of weeks. This is the first study to report short-term association between non-accidental mortality and ambient air pollution in Iran.

## **002.02.09. Association between Haemorrhagic Stroke Incidence and Atmospheric Air Pollutants**

Radoslaw Czernych

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Abstract: According to WHO estimates, of the 17.5 million deaths due to cardiovascular disease in 2012, an estimated 6.7 million were due to strokes. Evidence is increasing that short-term exposure to ambient air pollution is associated with increased incidence of haemorrhagic strokes. The purpose of this study is to determine risk of intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH) incidence depending on seasonal variations in air pollutants in the Gdansk agglomeration, Poland. From January 1, 2009 to December 31, 2014, 16,000 ICH and 3,500 SAH were registered among residents of Gdansk agglomeration, Poland. The authors calculated the relative risk (RR) of haemorrhagic stroke and its subtype incidence (I60, I61) based on time-series analyses and trend correlations of air pollution (NO<sub>x</sub>, SO<sub>2</sub>, CO, O<sub>3</sub> and PM<sub>10</sub>) and stroke incidence. The significance in difference in stroke incidence as well as concentrations of the above mentioned air pollutants was assessed using Mann-Whitney's test and t-test respectively. The obtained results indicate an increased, and statistically significant, incidence of strokes during the heating period (November-April). The daily stroke incidence in summer period was 2.22 compared with 2.51 ( $p = 0.002$ ) cases of stroke in heating period. Statistically significant factors increasing the risk of stroke were NO<sub>2</sub> (RR = 1.128,  $p < 0.05$ ), PM<sub>10</sub> (RR = 1.209,  $p < 0.05$ ) and with O<sub>3</sub> with 2 day lag (RR = 1.09,  $p < 0.05$ ). Our research results show the relationship between haemorrhagic stroke incidence and seasonal variations of concentrations of NO<sub>2</sub>, PM<sub>10</sub> and O<sub>3</sub>. The RR of haemorrhagic stroke was higher for a group of people over 65 years of age. Risk determined for women and men did not differ significantly. From our point of view, the assessment of the impact of the environment on the stroke incidence is important from the point of view of environmental policy and the creation of prevention programs, both on a local or global scale.

## **O02.02.10. The Effect of Asian Dust in Estimating the Mortality Effects of Ambient Particles, with Larger Dataset in Seoul, Korea from 1998 to 2015**

Garam Byun

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**Abstract:** Background: Asian Dust (AD) is a natural source of particulate matter (PM) in Korea and increase the concentration of PM remarkably. However, the characteristics of PM from AD differ from that of PM in usual days. Objectives: We investigated the effects of Asian dust in association between PM and mortality in Seoul, Korea, 1998-2015. Methods: We applied time-stratified case-crossover design to estimate the effects of PM<sub>10</sub> and PM<sub>2.5</sub> on non-accidental, cardiovascular and respiratory mortality. The effect estimates of PM were compared for all days in study period and days without AD events, with stratified analyses by sex and age group. Results: A 10 µg/m<sup>3</sup> increase in PM<sub>10</sub> and PM<sub>2.5</sub> was associated with a 0.15% (95% CI: 0.06, 0.24%) and 0.27% (95% CI: 0.07, 0.47%) increase in risk of non-accidental mortality, respectively, for all days. The associations were enlarged to 0.30% (95% CI: 0.18, 0.42%) and 0.33% (95% CI: 0.10, 0.55%) when AD days were excluded from the analyses. The difference in effect estimates between all days and non-AD days were larger in males and those who aged under 64 years compared to other groups. Conclusion: The change in composition of PM or behavior pattern of population during AD events might result in the different effect of PM during all days and non-AD days. Our study suggest that including AD days in the analyses is likely to underestimate the effect of PM in usual urban environment.

## 002.02C. Chemical Exposures and Interventions Using Systematic Reviews

### **002.02.11. Developing Criteria for Evaluating the Quality of Exposure Measurements in Epidemiological Studies during Systematic Review**

Rebecca Nachman

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**Abstract:** During a systematic review of epidemiological evidence on health risk from exposure to environmental chemicals, it may be necessary to develop criteria for evaluating the quality of exposure measurements that account for specific factors relevant to the chemical of interest. We describe approaches for developing chemical-specific criteria through three case studies for exposure to phthalates, methylmercury, and hexavalent chromium. Each case study began with a set of prompting questions aimed at answering the core question: Does the exposure measure reliably distinguish between levels of exposure in a time window considered most relevant for a causal effect with respect to the outcome? We then developed additional follow-up questions specific to each chemical (or class of chemical). We used a range of approaches to address the questions and draft chemical-specific criteria for rating exposure measurements as Good, Adequate, Poor, or Critically Deficient (Good indicating the least potential for bias in effect estimates due to exposure measurement error). The approaches and key chemical-specific criteria were as follows: For phthalates, based on a comprehensive review of the literature, we identified urine as the preferred biological matrix and emphasized repeat sample collection. For methylmercury we consulted multiple independent researchers with expertise in mercury biomonitoring and found agreement on the importance of standard reference materials and quality control related to mercury adherence to analytical equipment. For hexavalent chromium, we used existing guidance to develop criteria that take into account uncertainty due to the reduction of hexavalent chromium to trivalent chromium in air and biological samples. Further development of chemical-specific evaluation criteria can enhance the use of standard systematic review tools. The views expressed in this abstract are those of the author and do not necessarily represent the views or policies of the U.S. EPA.

## **002.02.12. Systematic Review of Mercury Exposures Worldwide: Findings from the 2018 WHO/UN Global Mercury Assessment**

Nil Basu

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Abstract: The Minamata Convention on Mercury Pollution provides a mandate to take action against global mercury pollution. However, our knowledge of mercury exposures around the world remains limited. As part of the 2018 UN Global Mercury Assessment, WHO led the current study to increase worldwide understanding of human exposures to mercury by collating and analysing mercury concentrations in biomarker samples via a systemic review. A systematic search of the peer-reviewed literature was performed with several a priori search strategies set. The overall work captured 424,884 mercury biomarker measures taken from 336,015 individuals represented in 312 articles from 67 countries. We identified four populations of concern for which there exist a relatively robust dataset: 1) Arctic populations (mainly Inuit) who consume fish and marine mammals; 2) tropical riverine communities (especially Amazonian) who consume fish, and in some cases may be exposed to mining operations; 3) coastal and/or small-island communities who are avid seafood consumers; and 4) individuals who either work or reside amongst artisanal and small-scale gold mining (ASGM) sites. Individuals in select background populations worldwide with insignificant exposures to mercury sources have blood mercury levels that generally fall under 5 mg/L and urine mercury levels that fall under 3 mg/L. This systematic review documents that all people are exposed to some amount of mercury, and that there is great variability in exposures around the world. This type of information is critical in helping understand exposures particularly in light of the Minamata Convention on Mercury Pollution and certain stipulations within the Convention text (e.g., can inform Article 22's effectiveness evaluation especially for vulnerable populations; gauge changes over geographic space and time).

## **O02.02.13. Interventions for Reducing Ambient Air Pollution and Their Effects on Health: Final Results from a Cochrane Systematic Review**

Hanna Boogaard

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**Abstract:** Interest in assessing the health effects of air quality interventions has grown in response to questions about the benefit of further tightening air pollution regulations. No systematic review has been performed to date with transparent and standardized protocols. In brief, standardized protocols were followed for study selection, assessing individual study quality and evaluating the body of evidence. Eligible studies assessed the effectiveness of any intervention aiming to reduce ambient PM air pollution from vehicular, industrial, residential or multiple sources with a range of study designs. Primary outcomes were PM concentrations and all-cause as well as cardiovascular and respiratory mortality. After a three-stage duplicate screening process of 33,462 unique titles, we included 44 interventions evaluated in 53 studies in 20 countries in the main analysis. Changes in PM<sub>10</sub> and PM<sub>2.5</sub> were assessed for 22 and 11 interventions, respectively, while only 16 studies assessed changes in health outcomes, including 9, 4 and 5 studies assessing total, cardiovascular and respiratory mortality, respectively. Studies included in the main analysis comprised controlled-before after studies and interrupted time series studies with and without a control site. Study quality varied widely. A graphical summary of the evidence showed that effect estimates were heterogeneous, and only some studies documented improvements in air quality and/or health. Given the few studies and the heterogeneity across interventions, outcomes, and study methods, it was difficult to generate any overall conclusions regarding the effectiveness of interventions in improving air quality or health. The review highlights the numerous challenges encountered such as lack of statistical power, background trends, and difficulties in direct attribution. The review provides possible directions and implications for future practice and research, including the use of causal inference methods that has shown promise.

## **002.02.14. Exposure to Formaldehyde and Effects on Asthma Outcomes: A Systematic Review and Meta-Analysis**

Juleen Lam

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**Abstract:** Background: Formaldehyde is found in virtually all homes and buildings. Low-income populations are disproportionately at risk of exposure. The relationship between asthma and exposure to formaldehyde has been under evaluation by government agencies for the last few decades; however asthma was not included in EPA's economic analysis of the benefits of regulating formaldehyde. Objective: We conducted a systematic review to answer the question: "is exposure to formaldehyde associated with diagnosis, signs, symptoms, exacerbation, or other measures of asthma in humans?" Methods: We conducted a comprehensive search of articles published up to February 2018. We included original studies that investigated indoor or outdoor sources of airborne inhalation exposure to formaldehyde incurred any time prior or concurrent to diagnosis or exacerbation of asthma. We developed and registered a protocol in PROSPERO, evaluated the potential risk of bias for each included study, identified a subset of studies combinable in a meta-analysis, and rated the quality and strength of the body of evidence. Results: We screened 4,482 references and identified 148 human studies that met our inclusion criteria; of these, 81 reported on the asthma status of participants; and of these, 10 studies (12 datasets) were deemed combinable in a meta-analysis for development of childhood asthma, 15 were combinable in a meta-analysis for exacerbation of childhood asthma, and 4 were combinable in a meta-analysis for adult asthma outcomes. Studies generally had low to probably-low risk of bias across most domains. A 10-fold increase in formaldehyde exposure was associated with an increased risk of asthma development for both indoor formaldehyde exposure (OR= 2.27 95% CI: [1.26, 4.09]) as well as ambient exposures (OR=1.03, 95% CI: [1.02, 1.04]). The final results of rating the quality and strength of the evidence and recommendations for prevention will be presented.

## **O02.02.15. Exposure Data Curation Using Dragon Online Flexible Forms**

Kevin Hobbie

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Abstract: Data curation is particularly challenging when conducting exposure assessments. Because exposure assessment requires integration of input data and measured concentrations from diverse data streams, data collected are in non-standard formats and reflect variability in data reporting. However, gathering and annotating necessary data is a critical step in conducting systematic reviews and exposure and risk assessments. To this end, ICF has developed a flexible data extraction form in DRAGON ONLINE, a web based collaborative platform designed to support all components of systematic literature reviews and exposure and risk assessments. DRAGON ONLINE allows data elements evaluated across scientific studies to be standardized while maintaining the flexibility to extract and store data that is fit for purpose. Flexible data extraction forms can be quickly built to suit the needs of a particular assessment. The web based platforms allows multiple users to extract data simultaneously and maintains records of decisions made throughout the systematic review process. The extracted data and decisions allow for quality control review, exporting of extracted data, and annotation of data curation steps. In this presentation, we will demonstrate forms developed for extraction of measured media concentrations, biomonitoring data, modeled media concentrations, and modeled doses. Extracted data for various environmental chemicals will also be presented in reports, graphs, and charts that support the integration of data across data streams to reach assessment conclusions.

## 002.02E. Household Environmental Risk Factors and Health

### 002.02.21. A Novel Approach to Examining Multiple Indoor Exposures in Early Childhood on the Inflammatory Pathway and Risk of Intermediate Outcomes for Childhood Asthma in the Canadian Healthy Infant Longitudinal Development (CHILD) Birth Cohort

Tim Takaro

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**Abstract:** Rationale: Oxidizing chemicals found in the indoor environment, particularly consumer products, can cause inflammation leading to respiratory illness. The CHILD birth cohort is a national study examining how environmental exposures interact with genetics, immune system, microbiome and other personal characteristics to impact the risk of developing asthma and allergies. Methods: 2700 of 3,455 children born into the CHILD cohort were included in this analysis. A comprehensive suite of indoor exposures with potential inflammatory properties (e.g. mold and moisture, cleaning products and other household chemicals, and pests) in infancy were combined into an Indoor Environmental Exposure Index (IEEI). Exposures were evaluated against asthma-related outcomes of recurrent wheeze, atopy and diagnosed asthma at age 3 years. Results: In logistic regression (adjusted for sex, parental atopy, income, ethnicity, and tobacco exposure) the IEEI at age 3 months was associated with a significantly higher risk of asthma and wheeze + atopy at 3 years of age in both continuous and interquartile comparisons, but not with atopy alone. IEEI as Continuous Variable .....IEEI Comparing Upper to Lower Quartile Outcome; Odds Ratio (95 % C.I.); Odds Ratio (95 % C.I.) Asthma 1.39\* (1.03 - 1.86) .....1.98\* (1.02-4.12) Atopy ...1.12 (0.94 - 1.33) .....1.37 (0.91-2.07) Wheeze+Atopy 1.56\* (1.03 - 2.38) 3.53\* (1.23-12.7) \*p-value < 0.05 Conclusions: Infants with wheeze, and wheeze with atopy are at higher risk for developing asthma later in life. Our findings indicate that ubiquitous indoor exposures in the first 3 months of life may contribute to higher risk of wheeze and atopy, which may ultimately lead to asthma later in life. Given the longitudinal nature of CHILD, we can add exposure periods at later ages and track these relationships with more definitive asthma development.

## **002.02.22. The Home Environment and Caregiver Stress of Children with Asthma in Low Income Rural Households**

Catherine Karr

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Abstract: Urban studies demonstrate adverse impacts of home environmental characteristics and caregiver stress on asthma morbidity. We characterize these features at baseline for participants in a rural asthma intervention study (Home Air in Agriculture Pediatric Intervention - HAPI). Staff administer a multi-component stress survey and conduct home environmental assessments. Micropem samplers are placed in the child sleeping area and home living area. Seventy-five child subjects completed the baseline assessments. All are Latino, age 6-12 years, and reside in non-smoking households. Two week geometric mean (GSD) PM2.5 and PM10 concentrations in the sleeping area were 10.6 ug/m<sup>3</sup> (2.2) and 19.9 ug/m<sup>3</sup> (1.8). Living room PM2.5 was 13.4 ug/m<sup>3</sup> (2.2). Visible mold was evident in 61% of homes, detectable by odor in 24%. Other common triggers identified were bleach/ammonia cleaner use (93%), air freshener use (59%), carpeting in the sleeping area (56%), rodent pests (44%), pesticide use indoors (35%), and indoor cat/dog (33%). Few had allergen mattress covers (12%). Approximately one third of caregivers scored in the higher ranges of perceived stress (PSS>15). The child's asthma reportedly caused stress in the family for 41%. Caregivers expressed lack of confidence in handling a severe attack (51%) and concerns for adverse effects of long-term asthma medication use (70%). Hispanic stress inventory components revealed high stress for some participants related to language (19%) and immigration (16%). While understudied, children in rural settings, including immigrant families, may face comparable or higher burden of home conditions, stressors, and resource limitations that threaten asthma control. Measured indoor particulate matter concentrations are lower than most urban studies but consistent with observations in other rural or nonsmoking homes. HAPI will test a community based home visiting and education program alone or with HEPA air cleaners on asthma outcomes in this setting.

## 002.02.23. Longitudinal Residential Exposures and Lung Function Until Age 16

Edith Milanzi

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**Abstract:** Background: Exposure to secondhand tobacco smoke (SHS), pets, and dampness and molds have been linked to reduced lung function. Distinct ranges of ages have been studied, but evidence for associations between longitudinal cumulative patterns of exposure and lung function is scarce. We investigated associations of longitudinal exposure to SHS, pets, and dampness and molds from birth/early life until age 14 with lung function growth between ages 12 and 16. Methods: We used data from the Dutch Prevention and Incidence of Asthma and Mite Allergy (PIAMA) cohort (N=1461). Data on residential SHS, pets, dampness and molds exposures, as well as health and lifestyle were obtained by questionnaires during follow up. Lung function (forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC)) was measured during medical examinations at ages 12 and 16. Time-varying residential exposures from birth/early life into adolescence were characterized into longitudinal patterns using Latent Class Growth Analysis (LCGA). We analyzed the associations of patterns of residential exposures with FEV1 and FVC using linear mixed effects models. Results: SHS exposure patterns were associated with reduced FEV1 growth e.g. -32.6 ml/year (95% confidence interval (CI): -43.4 to -21.7) and reduced FVC growth -20.7 ml/year (-32.9 to -8.4 ) for almost always exposure pattern vs. very low SHS exposure pattern. Pet exposure patterns were associated with increased FEV1 growth e.g. 11.1 ml/year (3.4 to 18.8) for high early life exposure vs. very low pet exposure pattern. Early life exposure to dampness and molds was associated with reduced FEV1 growth (-18.8 ml/year (-27.9 to -9.6 )) and FVC growth (-15.8 ml/year (-26.0 to -5.7 )) as compared to very low dampness and mold exposure pattern. Conclusion: Longitudinal residential exposures to SHS, pets and dampness and molds were associated with lung function growth from 12 to 16 years.

## **O02.02.24. Effects of Short-Term Exposure to Fine and Ultrafine Particles from Indoor Sources on Arterial Stiffness - A Randomized Sham-Controlled Exposure Study of Healthy Volunteers**

Vanessa Soppa

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**Abstract:** Introduction: Particulate air pollution is linked to adverse cardiovascular effects, including arterial stiffness. The aim of this study was to investigate the effect of short-term exposure to particles from indoor sources on arterial stiffness, assessed as augmentation index (AIx), augmentation pressure (AP) and pulse wave velocity (PWV). Methods: We used multiple mixed linear regression to analyze the association of particle emissions from 2h candle burning (CB), toasting bread (TB), and frying sausages (FS) with changes in arterial stiffness in 55 volunteers in a randomized cross-over controlled exposure study. Size-specific particle mass (PMC) and particle number concentration (PNC), and lung-deposited particle surface area concentration (PSC) were measured during the 2h exposure. AIx and AP were measured before, directly and 2h, 4h and 24hrs after exposure. PWV was measured directly and 24hrs after exposure. Results: We observed a significant increase in AIx of 6.3% (95%-CI: 1.1; 11.5) in the categorical analysis directly after the exposure CB, PM10 and PM2.5 from TB were associated with increases in AIx up to 4h after exposure, with highest associations for PM2.5 (8.1% (95%-CI: 2.5; 13.7) directly after exposure. PNC from FS and CB, was associated with significant increases of AIx after the exposure FS for all time points (range: 4.1% (95%-CI: 0.5; 7.6) after 2h; 5.9% (95%-CI: 1.5; 10.2) after 24hrs) and directly after the exposure CB (5.6% (95%-CI: 1.0; 10.2). PSC measured during FS was also associated with a 5.4% (95%-CI: 1.4; 9.4) and 4.2% (95%-CI: 0.1; 8.3) increase in AIx directly after and 4h after the exposure, respectively. The results of the PWV showed no distinct associations. Conclusion: Our findings show rapid increases in arterial stiffness in healthy individuals after exposure to typical indoor sources. These changes of central arterial indices differ concerning magnitude, duration, and association to specific particle metrics and particle sources.

## **O02.02.25. Ethical Challenges when Evaluating Household Health Risk**

Carl Grimes

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Abstract: Environmental epidemiology for outdoor exposures is well established and accepted. Exposure types and sources plus their relationships to public health are increasingly well-known. But such investigation typically stops at the front door of houses. Which is curious because people spend as much as 90 percent of their time indoors. Mothers, children, and the elderly - arguably the more vulnerable of the population - spend most of that 90% inside their household. Although people are the defined subjects of epidemiology, they are mostly studied as a group larger than that of a typical household; certainly not individually. Finally, the occupants of households are strangely unaware that their personal domain could ever be deleterious to their health. There are at least four questions with ethical implications: What are the justifications for excluding the dominant location of human environmental exposure? Do these arguably valid justifications offset the ethics of excluding the epidemiology of the indoor environment? Does the inherent complexity, along with the challenges associated with the statistical analysis of small groups, ethically justify their exclusion? Do environmental epidemiologists have an ethical duty to inform and alert the general populace of the potential risks of their indoor environment? These questions provide a framework for discussing ethics in this session.

## 002.02F. Lead Exposure and Health Effects across the Lifespan

### **002.02.26. The Effect of Prenatal Bone Lead Concentrations on Prepulse Inhibition: A Prospective Study of Mexican Children**

Kale Kponee

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**Abstract:** Background: An important concern is the toxic legacy of prenatal lead exposure. During pregnancy, maternal skeletal bone lead from earlier exposures mobilizes and crosses placental barriers placing the developing fetus at risk for lead exposure and subsequent neurobehavioral deficits. Some of the neuronal circuits implicated in mechanisms of neurodevelopment can be probed with simple physiological behavioral paradigms, potentially serving as a neurobehavioral marker of toxicant exposure. One such measure includes pre-pulse inhibition (PPI), a sensorimotor gating process that can modify the acoustic startle reflex (ASR) under different behavioral conditions. PPI impairment has been associated with neurodevelopmental deficits in children such as ADHD and early psychosis. To our knowledge, no studies have examined the effect of prenatal lead concentrations on PPI in children. Objective: The objective of this study was to determine the effect of prenatal bone lead concentrations on PPI in Mexican children 8-17 years of age. Methods: In vivo maternal bone lead measurements were taken at four weeks postpartum at the mid-tibia shaft and the patella using a K-Shell X-ray fluorescence (K-XRF) instrument. PPI responses were recorded in an isolated clinical setting and eye blink responses were assessed using electromyography. We used ordinary least squares regression adjusted for relevant covariates to model the relationship between prenatal bone lead and PPI. Results: Mean  $\pm$  SD lead concentrations in tibia and patella were  $9.33 \pm 10.00$   $\mu\text{g/g}$ , and  $12.27 \pm 12.17$  respectively. In adjusted models, higher tibia bone lead significantly reduced PPI in children. Patella lead concentrations were independent of PPI. Conclusions: In this population of Mexican children, prenatal tibia lead concentrations were associated with impaired PPI. These results suggest that lead may disrupt PPI, which could be a biological indicator of neurodevelopmental deficits in children.

## **O02.02.27. The Influences of Sociodemographic Characteristics and Changes in Blood Lead on the Concentration-Response Relationship between Blood Lead Level and Children's Intelligence Quotient**

Ellen Kirrane

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Abstract: Blood lead levels (BLLs) have decreased over the last several decades but lead exposure remains a risk and the relationship between socioeconomic status, lead, and neurodevelopment is not well-understood. Differences in the distributions of sociodemographic characteristics between children with higher and lower BLLs may account for the nonlinear concentration-response (C-R) relationship observed between BLL and cognitive effects in multiple studies. Specifically, adjustment for sociodemographic characteristics may be an over-adjustment leading to an underestimate of the association at the upper end of the distribution. We analyzed data from the US cohorts examined in the pooled analysis of Lanphear et al. 2005. Like the original analysis, we analyzed relationships of BLL and sociodemographic factors with child IQ using fixed effects multivariable generalized linear regression, and stratified the dataset into children with peak BLLs  $< 7.5$  and  $\geq 7.5$   $\mu\text{g}/\text{dL}$ . Unlike the original analysis we considered the interaction between concurrent BLL and sociodemographic factors and estimated the cumulative impact of BLL and sociodemographic characteristics across the distribution of IQ using quantile regression. The correlation of concurrent BLL with sociodemographic characteristics was generally stronger in the high peak blood lead group, potentially reducing our ability to distinguish the independent effect of blood lead from the effect sociodemographic factors at the upper end of the distribution. The cumulative effect of BLL and sociodemographic factors was largest at the upper end of the IQ distribution in the low peak BLL group suggesting the importance of considering baseline IQ. Overall, this analysis suggests that distribution of sociodemographic factors across the range of BLLs may explain, in part, the attenuation of the C-R relationship at higher BLLs. Disclaimer: Views expressed in abstract are those of authors and do not represent views/policies of the US EPA.

## **002.02.28. A Randomized Controlled Trial to Reduce Childhood Lead Exposure and Lead-Associated Neurobehavioral Deficits: The HOME Study**

Joseph Braun

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**Abstract:** Background: Childhood lead exposure is associated with neurobehavioral impairments in children. No randomized trials have tested whether a comprehensive residential lead hazard intervention can prevent elevated blood lead concentrations and associated neurobehavioral outcomes. Objectives: We tested whether an intervention designed to reduce residential lead exposure completed during pregnancy could prevent elevated blood lead concentrations and improve neurobehavioral outcomes in children. Methods: We enrolled 355 pregnant women from the Cincinnati, OH metropolitan area in a randomized controlled trial. We randomly assigned women to receive either residential lead or injury hazards. The lead hazard intervention included elements designed to reduce or eliminate lead exposure from paint, drinking water, and soil. We assessed residential dust lead loadings at baseline and when children were ages 1 and 2 years. From ages 1-8 years, we measured blood lead concentrations and assessed cognition, behavior, and executive functions. Results: The intervention reduced floor, windowsill, and window trough dust lead loadings at ages 1 and 2 years by 24% (95% CI: -43, 1), 40% (95% CI: -60, -11), and 47% (95% CI: -68, -10), respectively. The intervention non-significantly reduced children's blood lead concentrations (-6%; 95% CI: -17, 6). Race modified the intervention effect on children's blood lead concentrations (intervention x race p-value=0.03); Black children had greater reductions in blood lead concentrations (-31%; 95% CI: -50, -5) than White children (-2%; 95% CI: -14, 12). Neurobehavioral test scores were subtly better among children in the intervention group than control group; all were statistically non-significant, except for a reduction in anxiety scores (-1.6; 95% CI: -3.2, -0.1). Conclusions: This intervention reduced residential lead exposures and, among Black children, blood lead concentrations, but did not result in substantive neurobehavioral improvements.

## **002.02.29. Urinary Lead Concentration and Its Association with the Composition of the Adult Gut Microbiota**

Shoshannah Eggers

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Abstract: Imbalance of the gut microbiota has been linked to many adverse health outcomes including infection, and autoimmune disease. Along with its other detrimental health effects, lead (Pb) exposure may alter the composition of the gut microbiota, but this association has not been investigated in adults. This study examines the association between urinary Pb concentration and the composition of the adult gut microbiota in a non-clinical sample. Data are from the 2016 Survey of the Health of Wisconsin (SHOW) and its ancillary microbiome study. SHOW is a general population-based health survey of Wisconsin residents, collecting survey data on health determinants and outcomes, objective measurements of body habitus, and biological specimens including urine. The ancillary microbiome study collects additional survey data and biological specimens, including stool for microbiota analysis, from participants age 18+. Pb exposure was measured in urine and gut microbiota composition was assessed using 16S rRNA V4 region amplicon sequencing. Statistical analysis includes  $\alpha$  and  $\beta$  diversity metrics, multiple linear regression and PERMANOVA adjusted for relevant confounders, and SIMPER analysis. Of 467 participants, urinary Pb concentration was highest in those age 70+, those with a high school diploma or less, and current smokers. Creatinine adjusted log urinary Pb concentration was associated with a significant decrease in  $\alpha$ -diversity (Shannon  $p= 0.026$ , Inverse-Simpson  $p= 0.051$ ) but not richness, although interactions with age, gender, diet components and smoking status were significant.  $\beta$ -diversity was significantly different between participants in quartile 4 vs. 1 of urinary Pb (Jaccard  $p=0.049$ ), however no operational taxonomic units were significantly different between groups after correction for multiple comparisons. These novel results suggest that Pb exposure is associated with differences in the composition of the adult gut microbiota in a community-based human population.

## 002.02.30. Amyotrophic Lateral Sclerosis and Exposure to Lead in a Danish Cohort

Aisha Dickerson

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**Abstract:** Background: Amyotrophic lateral sclerosis (ALS) is a rare neurodegenerative disorder with rapidly progressive loss of voluntary motor function. Although a recent meta-analysis of occupational exposures and ALS showed a positive association between chronic lead exposure and ALS, results from several studies have yielded conflicting results. Objective: To investigate the association between occupational exposures to lead and odds of ALS. Methods: Utilizing data from a prospective Danish cohort study, we conducted a nested case-control study of occupation and ALS diagnosis. We identified ALS cases from 1982 to 2013 from the Danish National Patient Registry and 100 age- and sex-matched controls per case. Occupation history was obtained from the Danish Pension Fund. We excluded participants with less than 5 years of total work experience and those born more than 25 years before the Pension Fund was established to reduce healthy worker hire bias and exposure misclassification, leaving 1661 ALS cases and 155,169 controls. Cumulative lead exposures were estimated using a job exposure matrix. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) for exposure categories cut at the 30th and 60th percentiles of exposure were obtained using conditional logistic regression analyses and stratified by sex. Results: No significant results were seen in overall cumulative exposures. However, we observed a significant increase in ALS for men with > 50% probability of lead exposure in the highest percentile group during any point prior to the index date (aOR=1.29; 95% CI 1.01, 1.66), 5-year lag (aOR=1.33; 95% CI 1.03, 1.71), and 10-year lag periods (aOR=1.34; 95% CI 1.14, 1.72) compared to those with no exposure. We observed no trends. Conclusion: Our study suggests an association between higher lead levels in men with a high probability of exposure and ALS. These findings support those of previously reported associations between ALS and occupations commonly exposed to lead.

## S02.02A. E-Waste: A Growing Global Problem and Next Steps

### **S02.02.01. An Overview of the Sources and Hazards of E-Waste Exposure on Human Health**

Brittany Trottier

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Abstract: As the demand for electronics steadily increases throughout the world, the amount of electronic waste (e-waste) accumulates at a rapid pace. Countries such as India, Ghana, China, and Thailand are most impacted by the import and generation of e-waste. E-waste is composed of a combination of hazardous substances including lead, cadmium, chromium and PCBs, that are, by themselves, harmful to human health and contaminate the environment. Direct and indirect exposures to e-waste are a threat to vulnerable groups such as fetuses, children, pregnant women, and the workers in the informal sector that work without personal protective equipment. The majority of e-waste is recycled informally and without personal protective equipment, using primitive techniques such as burning and acid baths, that further exacerbates the exposure to and impact of the hazardous substances to human health. An overview of the health effects resulting from e-waste recycling practices and vulnerable populations associated with informal e-waste recycling will be touched on in this presentation.

## **S02.02.02. Biomonitoring of Female Vietnamese Electronic Waste Recyclers for Selected Metals and Organics**

Linda Birnbaum

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Abstract: Electronic waste (E-waste) has rapidly increased in recent decades, especially in developing nations. Recycling and reclamation of certain chemicals is frequently performed in low and middle income countries including Vietnam where relatively unregulated home based e-waste recycling is common. In 2012, a pilot study was conducted in 2 villages in northern Vietnam, with 10 women who conducted home-based recycling in one and 10 matched controls in another. This was followed in 2013, with a study of 40 recycling women vs 20 non-recyclers. Whole blood, serum, and urine were collected and analyzed at the US Centers for Disease Control for metals, persistent pesticides, PCBs, and both chlorinated and brominated dioxins and furans. PBDEs 47, 99, 100, 153, 154, 183, and 209 were elevated in the recycling women. PCBs 138/158 and 153 were elevated in the younger recyclers. Certain chlorinated dioxins (1,2,3,6,7,8-HxCDD) and furans (1,2,3,6,7,8-HxCDF and 1,2,3,4,6,7,8-HpCDF) as well as 1,2,3,7,8-PeBDD and 2,3,7,8-TBDF were also elevated in the recycling women. Surprisingly, p,p'-DDE was higher in the control women. Lead was elevated in the recycling women, while methyl mercury was higher in the non-recyclers. Of interest, arsenic, methyl mercury, and lead were elevated in both groups of Vietnamese women as compared to women of similar age in the US monitored in NHANES. Further study is indicated to understand not only exposure in a larger group of women doing home recycling, but the potential for adverse health effects from lead, PBDEs, PCBs, and dioxins as all these compounds appear to have neurodevelopmental, endocrine disrupting, carcinogenic, and others in multiple animal species and people. The high levels of arsenic and methyl mercury, as well as lead, in all the northern Vietnamese women is also of concern.

### **S02.02.03. E-Waste Recycling and Exposure Reduction Intervention in the Philippines**

Aimin Chen

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Abstract: E-waste recycling in the Metro Manila, Philippines, occurs in communities around the metropolitan area. It is usually operated by self-organized recyclers with connection to >2000 junkshops that collect recycled materials. Type of e-waste collected and recycled include cathode ray tube (CRT) TVs, monitors, computers, cell phones, refrigerators, fans, and microwave ovens. The recycling activities performed by thousands of recyclers mostly occur in front of their houses, on the streets, in the backyards, or along the rivers. The recycling activities include manual dismantling, crushing CRTs, burning power cords, and heating circuit boards. There is a lack of pollution control methods to reduce exposure. Limited research in Metro Manila informal e-waste recycling sites suggest increased levels of cadmium, cobalt, copper, manganese, nickel, lead, and zinc in soil samples, similar to findings from other large recycling sites in Asia. Open burning of e-waste also increases polycyclic aromatic hydrocarbon exposure in soil samples. A study in a Metro Manila waste dumping site identified slightly higher polybrominated diphenyl ether concentrations in breast milk compared with a control site. In 2012-2017, Médecins du Monde (Mdm, or Doctors of the World in English), a large non-government organization based in Paris, France, conducted pilot interventions to reduce exposures to e-waste toxicants among informal sector workers. Mdm has mobilized hundreds of informal e-waste recyclers in 4 communities in Metro Manila to form their own Recycler Organizations and conducted multi-prong interventions to mitigate environmental and health hazards. More research is needed to determine the effectiveness of the intervention for chemical hazard reduction.

#### **S02.02.04. Electronic Waste Recycling at Agbogbloshie, Ghana: A Global Problem, Current Intervention Strategies and Local Solutions**

Julius Fobil

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**Abstract:** The quantity of electronic waste (e-waste) generated around the globe is expected to increase with rising economies in Asia, Latin America and Eastern Europe largely as a consequence of the introduction of new products with shorter lifespan. Current global estimates of annual e-waste production exceed 40 million tons with an annual growth rate of 4 to 5 percent. However, in spite of the increased generation, there is a current lack of an efficient, safe and sustainable infrastructure for its disposal in many regions of the world; where a majority of the materials in the global e-waste stream ends up as final destination. A typical site in Ghana where the e-waste is received and recycled in an informal setting is the "Agbogbloshie dumpsite" and the lack of appropriate recycling infrastructure has meant that rudimentary and inefficient methods; such as manual dismantling, burning, shredding, melting, and leaching, are applied with resultant significant adverse consequence on human and environmental health. The Agbogbloshie example of e-waste recycling as highlighted in this talk presents the global e-waste production not only as an emerging global health problem, but also as a developing global security issue. More research is therefore needed at the local level to better guide intervention strategies aimed at reducing environmental exposures associated with current recycling methods, while awaiting the development and deployment of acceptable, inexpensive, more efficient and environmentally cleaner technologies.

## S03.04B Exposure and Risk Assessment of Chemicals in Consumer Articles

### **S03.04.06. The European Chemical Industry Guidance on REACH Exposure Assessment Strategies for Substances in Articles**

Tatsiana Dudzina

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Abstract: Under the European Regulation on Registration, Evaluation and Authorization of Chemicals (REACH) safety assessments of hazardous substances should cover all identified end-uses, including those that lead to the inclusion into articles. Characterization of risks to human health and/or the environment from the subsequent service life cycle stage requires a substantial level of detail on article composition, design, manufacturing process, use patterns under normal reasonably foreseeable conditions, i.e., the information that is not typically available or provided to chemical manufacturers by their downstream users. To overcome this lack of supply chain communication and to ensure consistency in understanding and addressing the problem across all REACH stakeholders, the European Chemical Industry Council (CEFIC) has developed a practical guidance/framework for REACH registrants to help them screen for the necessity of developing exposure scenarios for the service life stage of their substances based on the (limited) information available in the downstream sector use maps. The decision-making framework in the guidance utilizes REACH use description elements such as contributing scenario names, sector of use, and technical function of the substance, as well as the article characteristics known to drive release/exposure potential (e.g. article matrix, shape, intended use pattern). The presentation will outline the decision tree and include introduction to the Release from Articles Potential (RAP) Excel-based tool designed to assist on the determination of a substance's release/emissions based on its technical function in the article. Application of the workflow will be demonstrated with examples for two substances used in the road construction applications and polymer production.

### **S03.04.07. Ranking of Plastic Additives Based on Their Relative Potential for Release from Articles**

Andreas Ahrens

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Abstract: The release of hazardous substances from plastic materials is an area of high public interest. During the first two registration deadlines under REACH, several hundred substances potentially used as additives in plastics have been registered in volumes of 100 tonnes/year or more. However, for many of these substances, there is significant uncertainty on the hazards and the potential releases from plastic matrices. In late 2016, ECHA and a number of industry sector organisations have started a joint effort for characterising the uses of the various plastic additives and the corresponding potential for release from articles. This work aims to support i) industry in improving the REACH registration information on the uses of plastic additives and the related exposure potential, and ii) authorities in prioritisation and de-prioritisation of substances for initiation of regulatory processes. The presentation focuses on approaches and learnings from ranking plastic additives: - Data needed to predict the release potential: list of confirmed plastic additives, substance properties determining the release behaviour, additive function and concentration, relevant polymer and article type. - Ranking method: Development of a robust method to compare the release potential of additives from different plastic matrices. - Generation of ranking lists: Grouping of additives by function and ranking according to their release potential. In a subsequent step, the hazard information available for the single additives is combined with their relative release potential, in order to arrive at a risk-based prioritisation and de-prioritisation for regulatory processes. One example for the outcomes of the exercise is the identification of substances i) with significant uncertainties regarding the hazard and ii) having at the same time a high potential for release.

### **S03.04.08. Overview of Approaches to Estimate Consumer Exposure to Articles**

Eva Wong

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Abstract: Consumer articles can be significant sources of indoor chemical exposures. Exposure estimates can be developed using measured exposure data, modeling approaches, or a combination of both. The U.S. EPA's Office of Pollution Prevention and Toxics (OPPT) has augmented our suite of exposure estimation tools with updates to the Consumer Exposure Model (CEM), the Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned zones (IECCU) model, and the development of protocols to experimentally determine exposure parameters. OPPT has also completed a second version of indoor exposure testing protocols. The updated protocols have information on experimentally determining the chemical content in products or articles; emission rates, including short- and long term emission rates, material-air partition coefficients; solid phase diffusion coefficients; generation of particles by abrasion; direct transfer of chemical to dust in contact with an article; chemical transformation due to photolysis; migration rates, including chemical migration from an article into water, saliva, and sweat; and dermal exposure to chemicals transferred from liquids or particles to the skin. This presentation will provide an overview of the interrelatedness of consumer exposure models and available empirical data for estimating exposure. This relationship will be shown by providing an example of how CEM and IECCU can be used to estimate exposure to articles using available defaults and how those estimates change when incorporating article and chemical-specific empirical data. The views expressed in this abstract are those of the authors and do not represent Agency policy or endorsement.

### **S03.04.09. Evaluation of Polymers Migration Models**

Hua Qian

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Abstract: Polymer materials have been widely used as food packages because of various advantages they have including lightweight, durability, easy shape formation etc. During the manufacture process of polymer materials, additives such as antioxidants or colorants may be incorporated to improve the properties of polymers. When the polymer package contact with food, chemicals within Food Contact Materials (FCMs) can have the potential to migrate into food products. Quantifying the migration can help to understand and evaluate consumer's exposure to these chemicals originated from FCMs and ensure the safety of the food at consumption. Besides the laboratory migration testing, various computational models have been developed and used to simulate the chemical diffusion process within FCMs under various conditions. This presentation will provide an overview of the main types of migration models available, their theoretical basis, regulatory applicability in both the US and EU.

### **S03.04.10. Mouthing Exposure Estimation Tool under Canada's Chemicals Management Plan**

Adam Griffiths

*Adam Griffiths<sup>1</sup>*

*1. Health Canada, Ottawa, ON, Canada.*

Abstract: As part of Canada's Chemicals Management Plan, Health Canada assesses exposure to the general population, including vulnerable subpopulations such as children, from industrial chemicals. Children from birth up to 8 years of age are known to be prone to mouthing behaviours, such as sucking, biting and chewing products, which increase their oral exposure to certain contaminants. The presenter will provide an overview of an in silico tool built into Microsoft Access 2010 that allows for rapid estimation of such exposures, providing both exposures (e.g., ug/day) and doses (e.g., ug/kg/day). Thirty-three algorithms, collected from the publicly available literature, are built into the tool, and cover exposures via three pathways: direct object mouthing, swallowing of an object or material, and hand-to-mouth contact. The algorithms are generally not limited to certain chemical classes, and tend to be based on a similar type of equation, consisting of a release rate or concentration, contact rate, exposure duration, and body weight. The tool contains helpful descriptions for each algorithm, including the equation, the assessment tier (e.g., Tier 1, 2), prior use by other agencies, and the reference. In addition to these algorithms, the tool contains recommended upper-bound and central tendency default values for most parameters, for which most are user modifiable. While the tool estimates exposures for one object at a time, multiple algorithms, age groups and substances can be run in batch mode per object. The presenter will describe how the tool can be run, including how to specify scenarios and substance information, how to select applicable algorithms by material and product type, how to input or modify parameter values, and how to use the reporting and export functions. The presenter will also briefly highlight how the tool itself may be modified to suit the program needs of other regulators.

## S02.02C. Monitoring Versus Modeling PM2.5 Concentrations: Does It Matter for Air Pollution Health Effects?

### **S02.02.11. Use of Fine-Resolution AOD-Derived Long-Term PM2.5 Concentrations to Characterize Adverse Health Outcomes**

Joel Schwartz

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**Abstract:** Remote sensing data from satellites, which can be combined with land use, meteorology, and chemical transport simulations, and trained at monitoring locations, have some distinct advantages over monitoring data in assessing health effects of air pollution. Compared to monitoring data, they can provide fine scale spatial resolution and access to populations not living near monitors; compared to land use regression they can provide fine scale temporal resolution; and compared to inexpensive monitors they can provide better accuracy and historical estimates going back over a decade. I discuss several such models, their performance, and demonstrate how they perform in different studies compared to monitors. In the VIVA birth cohort, an IQR increase in modeled PM2.5 had a stronger association between Impaired Glucose Tolerance (OR=1.64 (1.11, 2.42)) compared to monitored PM2.5 (OR=1.34 (0.98, 1.84)). In the Medicare Mortality cohort they provide somewhat stronger associations between mortality and PM2.5, but much stronger associations with ozone HR= 1.011 (1.010-1.012) Vs 1.001 (1.000-1.002) for 10 ppb. In the New Jersey mortality data they allow differences in differences approach within census tracts that would not be feasible with monitors.

## **S02.02.12. Central Versus Local: Long-Term Exposure to PM2.5, Black Carbon, NO2 and O3 in the European Elapse-Project**

Gerard Hoek

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**Abstract:** Background: We recently started an analysis of the mortality and morbidity effects of low level air pollution in Europe. The study includes the pooled ESCAPE cohort (11 cohorts across Europe including detailed individual covariate data) and seven large administrative cohorts. This presentation discusses the two methods of exposure assessment for the European ELAPSE study population. Methods: Models were developed for PM2.5, NO2, BC and O3. The first method involves European-wide hybrid land-use regression (LUR) models incorporating routine monitoring data, land-use and traffic data supplemented with satellite observations and dispersion model estimates. The second method consists of local exposure models, including dispersion models and for some cohorts published study-area specific LUR models. Results: The European hybrid model explained a large fraction of measured spatial variation at the European scale. Predictors differed per pollutant. Particularly the PM2.5 model had moderate performance when evaluated with external measurements at the country or smaller scale. Local dispersion models were different in model principle, input data and spatial scale in the various study areas. Conclusions: Strengths and limitations of the two type of models with regard to health effects analyses include harmonization and validity when applied to specific areas.

### **S02.02.13. Using Fused Chemical Transport Models to Estimate Spatially and Temporally Resolved Ambient Air Pollution in Georgia and North Carolina**

Ted Russel

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Abstract: A number of adverse health impacts, including acute cardiovascular disease-related events, have been associated with exposure to fine particulate matter (e.g., PM<sub>2.5</sub>). Given the prevalence of data for PM<sub>2.5</sub> mass concentrations, most of these studies are based upon total PM<sub>2.5</sub> mass, not on individual species. However, a number of studies have found differing associations of disease outcomes with PM<sub>2.5</sub> components (or species), and PM properties (e.g., size and oxidative potential: OP). Data assimilation using chemical transport modelling (CMAQ) and observations is used to develop concentration fields of major PM<sub>2.5</sub> components for two areas: Georgia and North Carolina. As part of a cohort study of birthweight, speciated PM<sub>2.5</sub> and gaseous pollutant fields were constructed over Georgia for 2002-2006. Increases in air pollutant concentrations were associated with decreases in mean birth weight. In this study, speciated PM fields are also constructed over North Carolina for 2002-2009 studying patients who had undergone a cardiac catheterization in North Carolina. As part of a comparison of approaches, the model-observation fusing approach used here for PM<sub>2.5</sub>, performance was similar to using a method including satellite data as well as more coarse resolution modelling and provided speciated PM<sub>2.5</sub> fields as well as gaseous pollutants that are not as readily observed using remote sensing methods, or where such observations are temporally constrained. Speciated spatiotemporal fields developed here include elemental and organic carbon (EC/OC), sulfate, nitrate, ammonium, and crustal material. The CMAQ approach also provides NO<sub>x</sub>, O<sub>3</sub> and CO fields, and can also estimate additional properties such as aerosol pH and oxidative potential. While this work was funded, in part, by the US EPA, this abstract does not necessarily reflect EPA policy.

## **S02.02.14. Mortality Effects of Ambient Fine Particulate Matter Estimated Using Ground-Based Versus Remote Sensing Exposure Estimates**

Michael Jerrett

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**Abstract:** Background: Remote sensing (RS) is increasingly used for exposure assessment in epidemiological and burden of disease studies, including those investigating whether chronic exposure to ambient fine particulate matter (PM<sub>2.5</sub>) is associated with mortality. Objectives: To compare relative risk estimates of mortality from diseases of the circulatory system for PM<sub>2.5</sub> modeled from RS with that for PM<sub>2.5</sub> modeled using ground-level information and atmospheric chemistry models. Methods: We geocoded the baseline residence of 668,629 American Cancer Society Cancer Prevention Study II (CPS-II) cohort participants followed from 1982 to 2004 and assigned PM<sub>2.5</sub> levels to all participants using seven different exposure models. Most of the exposure models were averaged for the years 2002-2004, while one RS estimate was for a longer, contemporaneous period. We used Cox proportional hazards regression to estimate relative risks (RR) for the association of PM<sub>2.5</sub> with mortality from circulatory and from ischemic heart disease. Results: Estimates of mortality risk differed among exposure models. The smallest relative risk was observed for the RS estimates that excluded ground-based monitors for circulatory deaths (RR = 1.02 (95% confidence interval (CI): 1.00-1.04 per 10 µg/m<sup>3</sup> increment in PM<sub>2.5</sub>). The largest relative risk was observed for the land use regression model that included traffic information (RR = 1.14, 95% CI: 1.11-1.17 per 10 µg/m<sup>3</sup> increment in PM<sub>2.5</sub>). Conclusions: We found significant associations between PM<sub>2.5</sub> and mortality in every model; however, relative risks estimated from exposure models using ground-based information were generally larger than those estimated with RS alone. When all seven estimates were pooled, the estimates using ground-level information dominated the pooled estimate.

## **S02.02.15. Comparison of Long-Term PM<sub>2.5</sub> Concentrations from Ground-Based Monitoring, CMAQ Models and Satellite-Derived AOD to Characterize Adverse Cardiovascular Outcomes**

Laura McGuinn

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**Abstract:** Background: Adverse cardiovascular events have been linked with particulate matter <2.5 µm (PM<sub>2.5</sub>) exposure obtained primarily from air quality monitors, which rarely co-locate with participant residences. Modeled PM<sub>2.5</sub> predictions at finer resolution may more accurately predict residential exposure, though few studies have compared results across different exposure assessment methods. Methods: We utilized a cohort of 5679 patients who had undergone a cardiac catheterization between 2002-2009 and resided in North Carolina. Exposure to PM<sub>2.5</sub> for the year prior to catheterization was estimated using data from air quality monitors, Community Multiscale Air Quality (CMAQ) fused models at the census tract and 12km spatial resolutions, and satellite-based models at 10km and 1km resolutions. The coronary artery disease (CAD) index was used to measure severity of CAD, and individuals with an index >23 were considered positive cases with hemodynamically significant lesions. Separate models were constructed for each exposure metric, and logistic regression was used to model odds of having CAD or a recent myocardial infarction (MI) with each 1-µg/m<sup>3</sup> increase in PM<sub>2.5</sub>, adjusting for sex, race, smoking status, socioeconomic status, and urban/rural status. Results: Correlations between exposure metrics ranged from 0.6 to 0.9 and mean annual average PM<sub>2.5</sub> levels ranged from 12.3 to 12.8 µg/m<sup>3</sup>. Interquartile ranges varied across metrics with an IQR of 0.8 for 10km-satellite models and 1.3 for 1km-satellite models. The elevated odds for CAD>23 and MI ranged across exposure metrics, with a CAD odds ratio of 1.04 (95%CI: 0.99, 1.10) for monitored data and 1.13 (95%CI: 1.06, 1.21) for 10km-satellite data. Results differed by urban/rural status when using the monitored and census tract-CMAQ metrics. Conclusions: Long-term air pollution exposure was associated with coronary artery disease for both modeled and monitored data. This abstract does not necessarily represent EPA policy.

S02.02D. Opportunity to Accelerate Knowledge on Complex Developmental Chemical Exposures and Child Health: Environmental Influences on Child Health Outcomes (ECHO)

**S02.02.16. Accelerating Research on Chemical Exposures and Child Health Outcomes through ECHO: An Overview**

Jessie Buckley

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**Abstract:** Background: The Environmental Influences on Child Health Outcomes (ECHO) program is a seven-year U.S. National Institutes of Health initiative launched in 2016 to advance knowledge of the effects of a broad range of environmental exposures on child health and development. Objective: To provide an overview of the ECHO program as it relates to understanding relationships between early life chemical exposures and child health outcomes. Methods: We overview ongoing efforts related to chemical exposures and child health outcomes in ECHO by describing existing chemical exposure information and plans for new data collection. Results: ECHO's observational component leverages data from 84 extant longitudinal cohorts with more than 50,000 children from diverse backgrounds across 44 states, Puerto Rico, and the District of Columbia. The earliest cohort enrolled participants beginning in the 1980s while others have ongoing enrollment. Most cohorts began recruitment during gestation and all cohorts follow children longitudinally and collect biospecimens. ECHO includes working groups dedicated to chemical exposures as well as five outcome focus areas: 1) pre-, peri- and postnatal outcomes; 2) obesity and its consequences; 3) upper and lower airway conditions; 4) neurodevelopment; and 5) positive health. Existing chemical exposures data already collected by some ECHO cohorts includes chemical biomonitoring data, estimates of outdoor air pollution or geographic proxies of air pollution, environmental or personal exposure monitoring, and questionnaire data. In addition, all ECHO cohorts will contribute certain existing and new data as part of the ECHO-wide Cohort data collection protocol, including biospecimens and exposure questionnaires at key life stages of development. Conclusion: By combining rich, longitudinal data with team science approaches, ECHO will accelerate novel and policy-oriented research to address complex environmental health questions.

## **S02.02.17. Leveraging Variability across Space and Time to Assess Air Pollution Exposures and Child Health in ECHO**

Heather Volk

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**Abstract:** Background: Air pollution exposure is ubiquitous with demonstrated effects on morbidity and mortality. A more recent, growing literature suggests that prenatal air pollution exposure affects neurodevelopment. Objective: We describe current methods for air pollution exposure assessment, summarize existing studies of air pollution and neurodevelopment, and synthesize this information as a basis for recommendations, or a blueprint, for evaluating air pollution effects on neurodevelopmental outcomes in ECHO. Methods: We review peer-reviewed literature on prenatal air pollution exposure and neurodevelopmental outcomes, including autism spectrum disorder, attention deficit hyperactivity disorder, intelligence, general cognition, mood, and imaging measures. We compiled and evaluated cohort data to assess frequency of neurodevelopmental assessments and prenatal and infancy residential address locations. Cohort recruitment locations and enrollment years were summarized to examine potential spatial and temporal variation present in ECHO. Results: While the literature broadly suggests that prenatal air pollution effects neurodevelopment, limitations in spatial and temporal exposure variation exist for current published studies. Additionally, current sample sizes do not allow for well-powered investigations of mixtures, effect modification, or evaluation of windows of susceptibility to exposure. As over 90% of the ECHO cohorts have collected a prenatal or infancy (birth to 12 months) address, with the majority of recruitment spanning the last 20 years, application of advanced geographic information systems (GIS) based models for common air pollutant exposures may be ideal to address limitations of published research. Conclusions: In ECHO we have the opportunity to pioneer unifying exposure assessment and evaluate effects across multiple neurodevelopmental outcomes, setting the standard for evaluation of prenatal air pollution exposures with the goal of improving children's health.

## **S02.02.18. Mapping Chemicals across Routes of Exposure and Body Burden: Data Gaps and Opportunities for ECHO**

Deborah Bennett

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**Abstract:** Background: Tens of thousands of chemicals are used in the U.S.; however, there is a paucity of information on the impact of these agents on children's health. Biomonitoring can permit an assessment of exposure through multiple routes; but only when methods are available. Objective: We postulate that published literature, government databases, and other sources contain understudied chemicals that may impact health outcomes of interest in ECHO. Methods: We developed a list of chemicals occurring in environment media from industrial processes and/or found in consumer products to which mothers and children could be exposed and which have the potential for toxicity. We gathered additional information on these compounds through a semi-structured review of peer-reviewed literature and several governmental databases. Factors being considered include: (a) likelihood of exposures based upon the level and frequency of detection in environmental media, (b) levels previously found in human biofluids, (c) predicted exposures from using consumer products, and (d) toxic potency, from published in vivo and in vitro test results, from priority lists of hazardous chemicals, and from predictive toxicity modeling. Results: We used a framework to evaluate the varied data for the numerous compounds to categorize and rank compounds as to the potential level of concern. The resulting categories are 1) compounds recommended for inclusion in ECHO 2) compounds for which we encourage more toxicological or exposure data to be generated, and 3) the use of untargeted assays in select subpopulations to evaluate feasibility of quantifying emergent and unknown chemicals/metabolites as biomarkers. Conclusions: We anticipate that expanding the compounds included in studies such as ECHO will increase the probability of finding chemicals potentially associated with adverse health effects in children.

## **S02.02.19. Prioritizing Chemicals for Biomonitoring in ECHO to Maximize Public Health Impact**

Tracey Woodruff

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**Abstract:** Background: Environmental Influences on Child Health Outcomes (ECHO) is an NIH program linking 84 existing longitudinal cohorts of more than 50,000 children from across the US to understand effects of environmental influences on child health and development. ECHO represents an unprecedented opportunity to improve our understanding of developmental chemical exposures and during childhood and their associations with a range of adverse health outcomes. Objective: We reviewed current chemical exposure data available in ECHO and provided a framework for identifying and informing future research activities. We surveyed the ECHO cohorts to collect information on cohort measurements of chemical exposure through biomonitoring. We developed a framework to prioritize current and future research. Results and Discussion: Out of the 84 cohorts in ECHO, about 60% have existing or planned chemical biomonitoring data. More than a dozen classes of chemicals are being measured. The chemicals most frequently being measured are biomarkers of tobacco, environmental phenols, and phthalates. A smaller proportion of cohorts are measuring metals, PBDEs, PCBs, PAHs, organochlorine pesticides, or organophosphate pesticides. Only a handful are measuring perfluorinated compounds, pyrethroids, perchlorate, or disinfection byproducts. Most of the chemicals are measured prenatally or at delivery, with fewer cohorts measuring chemicals during childhood; a few cohorts measure preconception and paternal biomarkers. ECHO outcome focus areas include pregnancy outcomes, respiratory health, neurodevelopment, and obesity. We propose five categories of priorities for biomonitoring which consider the degree of current scientific information on chemical health effects, opportunities for new discovery, and the extent of health concern among the public given historical bans/phase outs. We will present our priorities for current and future chemical analysis to leverage this rich cohort to advance child health.

## **S02.02.20. Accessing ECHO Data to Address Innovative Hypotheses**

Jessie Buckley

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**Abstract:** Background: The Environmental Influences on Child Health Outcomes (ECHO) program will establish a national data resource platform with which scientists can address a wide variety of research questions about the etiology or prediction of child health outcomes. Objective: To discuss ECHO's publications policies and future opportunities for the general environmental health sciences community to access ECHO data. Discussion: ECHO's Publications Committee has established policies regarding the development and review of research products that include data or investigators from more than one ECHO awardee. The first step for investigators wishing to initiate a research product is to submit an Analysis Concept proposal. These proposals are initiated by writing teams, which can include researchers within or outside the ECHO program. Analysis concept proposals related to chemical exposures may utilize extant data or propose new biomonitoring utilizing stored biospecimens. Analysis Concepts are circulated to the ECHO scientific community with the goal of soliciting input on the scientific aims and additional writing team members. Next, the writing team develops and submits an Analysis Proposal with input from ECHO's Data Analysis Center. The Analysis Proposal is submitted to the Publications Committee for review and then evaluated by the ECHO Steering Committee for final approval. Additional information on current procedures and timelines for data access by non-ECHO investigators will be described, followed by a question and answer session.

## S02.02E. Solutions for Tackling the Link between Complex Exposures and Human Health

### S02.02.21. Simplicity in Complex Environmental Health Problems Using the Exposome

Dimosthenis Sarigiannis

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Abstract: Simplicity in environmental health warrants finding simple solutions while embracing the complexity in the links between multiple and complex environmental exposures and human health responses. It requires integration of multiple datasets, bringing together big data analytics with high dimension systems biology and advanced epidemiological analysis. The objective is to support the development of precision prevention strategies that protect public health while ensuring cost-effectiveness and addressing environmental health inequities. This is greatly facilitated by the advent of new high throughput analytical and multi-sensing methods supporting their coming together in the quest to create the premise for delivering precision medicine. Even though this is a true revolution for the promotion of good health and cost-effective healthcare on the individual level, public health promotion warrants paying equal attention to prevention and avoidance/reduction of human exposure to the stressors that contribute to ill health. The exposome, the totality of exposures over one's lifetime, and the genome are the two main determinants of human health. Effectively coupling genetic information with environmental and exposure-related data, as well as capturing epigenetic perturbations and linking them with mechanisms of toxicity and adverse outcome pathways maybe the solution towards the development of efficient environmental policies that protect both the quality of the environment, ecosystem function and human health. Unlike the traditional environmental epidemiology paradigm, computational exposure biology and exposome-wide association studies embrace all factors that determine or modulate human health and its interaction with the exposome. Pre-existing health conditions, prior exposures or deleterious habits such as smoking, but also age, gender, socio-economic status are considered part of an individual's exposome. This paves the way towards effective precision prevention policy.

## **S02.02.22. Lifelong Exposure of Population Subgroups with PM2.5**

Naixin Li

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Abstract: Fine particulate matter (PM2.5) is one of the mostly concerned air pollutants that are associated with premature mortality and other diseases. Existing studies mainly focus on assessing exposure to PM2.5 for a short period of time; however the health status of persons is influenced by long-term exposure over life course. To support the health impact assessment, we developed and applied a probabilistic model to estimate the temporal course of the external exposure to PM2.5 for persons that are characterized by certain features (e.g. age, gender, employment status, income). The annual average background concentration fields for Europe since 1930s are generated and applied as input data for PM2.5 concentration modelling for different microenvironments. Other parameters for concentration simulation include indoor sources, physical factors (e.g. ventilation rate, decay rate) and enrichment factor for traffic. Data of time activity pattern from MTUS are utilized to simulate the time-weighted average exposure for each year. The results of annual exposure are applied in a life trajectory model to assess the lifelong exposure to PM2.5. This methodology is applied to population samples from EU-SILC data. The concentration modelling for residential microenvironment is evaluated with measurement data from EXPOLIS study. 70% of the samples are within the range of 25th to 75th percentile of the modelling distributions. Exposure to PM2.5 varies substantially among population living in different countries and time periods. The influences of socioeconomic variables including income and employment status are noted as well. Penetration from outdoor is one of the most important sources, while exposure from other sources is affected by population behavioral patterns (e.g. smoking habits, use of wood stove). Installation of advanced ventilation system is revealed effective in decreasing indoor concentration level.

## **S02.02.23. Integrated Use of Agent Based Modelling (ABM) with Wearable Sensors for Personal Exposure Assessment**

Dimitris Chapizanis

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**Abstract:** Considering the substantial hurdles involved in collecting individual data for whole populations, this study introduces a first approach of simulating human movement and interaction behaviour, using Agent Based Modelling (ABM). A city scale ABM was developed for the urban area of Thessaloniki, Greece. The model feeds into population-based exposure assessment, basing its estimations onto emerging behaviours of all the heterogeneous entities (agents) that compose the city-system. Population statistics, road and buildings networks data were transformed into human, road and building agents respectively. Time-use survey outputs and personal sensor collected data were associated with human agent rules, aiming to model representative to real-world routines. In addition, time-geography of exposure data, derived from a personal sensors campaign on 100 households, was used to inform the model. As a prevalence of an agent-specific decision-making, virtual individuals of different sociodemographic backgrounds express different spatiotemporal behaviours and their trajectories are coupled with spatially resolved pollution levels. Personal exposure was evaluated by assigning PM<sub>2.5</sub> concentrations to human agents based on coordinates, type of location and intensity of encountered activities. Study results indicated that PM<sub>2.5</sub> inhalation adjusted exposure between housemates can differ by 32% whereas exposure between two neighbours can vary by as much as 77%, due to the prevalence of different behaviours. This approach permits the cost-effective construction of time-activity diaries and daily exposure profiles, considering different microenvironments and socioeconomic characteristics. The proposed method leads to a refined exposure assessment model, addressing effectively vulnerable subgroups of population. It can serve as a tool to evaluate probable impacts of public health policies prior to implementation, reducing the time and cost required to identify effective measures.

## **S02.02.24. Unraveling the Complex Etiology of Neurodevelopmental Disorders: Tools, Key Issues and Research Needs to Investigate the Environmental Contribution**

Gemma Calamandrei

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"Abstract: Events occurring in the earliest stages of human development may influence both resilience and vulnerability to later neuropsychiatric/neurologic disorders. Research in animals has shown that diverse environmental stressors may interfere with typical brain development in critical time windows, inducing silent sub-clinical alterations that may hesitate in behavioral alterations at later life stages. Epidemiological prospective studies have in many cases supported the link between sub-toxic exposure to chemical pollutants and neurobehavioral effects in children. Recent advances in research offer important clues into the complex etiology of autism and other neurodevelopmental disorders (NDDs). The convergence of risk factors on the same cell/molecular pathways combined with a vulnerable gene makeup would trigger the development of the disorders or predispose to adverse outcome later on. The exposomic approach may help unraveling this complex etiology through characterization/quantification of exogenous and endogenous exposures and modifiable risk factors for NDDs. A critical issue is validation of peripheral biomarkers of effects that can inform on typical and atypical brain development, and establish biologically plausible links between chemicals and health effects in humans. Laboratory studies might contribute by modeling in "simpler" living organisms and systems the complexity of the human exposure scenarios. This would also entail the discovery of "omic" signatures anchored to the behavioral phenotype. Targeted in vivo studies will possibly empower the human exposome with peripheral accessible markers of susceptibility, vulnerability and effects, mirroring the effects in brain and able to predict the behavioral outcomes of developmental exposure to neurotoxicants and endocrine-disrupting chemicals. This integrated approach is being applied to establish the link between environmental stressors and child neuropsychological health in some European birth cohorts. "

## **S02.02.25. Use of Exposome to Explain the Allergy Epidemics**

Isabella Annesi-Maesano

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*1. EPAR IPLESP, INSERM & Sorbonne Université, Paris, France.*

Abstract: Worldwide, up to 50% of individuals will suffer from at least one allergy by 2050 due to environmental changes. Although daunting, proof of concept studies are being conducted that show the promise of the exposomic investigation and integration of different kinds of data to explain the allergy epidemics; the exposome being the totality of external environmental exposures (external exposome) to which an individual is exposed in life and their consequences in the body (internal exposome). The specific external exposome acting on allergic diseases include indoor and outdoor aeroallergens and chemical air pollutants. To it has to be added non-specific external exposome, namely the action of climate change, urbanization and loss of biodiversity that affect sources, emissions and concentrations of main aeroallergens and chemical air pollutants. In this context, thunderstorm-related asthma is a dramatic example of the effects of combined environmental factors and an in vivo model for understanding the mechanisms at work in respiratory allergy. In terms of internal exposome, environment- or lifestyle-driven aberrancies in the gut and skin microbiome composition represent a key mediator of allergic diseases. In addition, the role of epigenetic mechanisms (particularly DNA methylation) in allergic disease is also considered in the implementation of the exposome because these mechanisms are known to be at the interface among gene regulation, environmental stimuli and developmental processes, all of which are essential for the pathogenesis for asthma and allergies. Tools and methods to implement the external and internal exposome (sensors, geographic information systems, and ad hoc survey instruments) will be presented. A better knowledge of the impact of the exposome on allergy development is crucial for urging individuals, health professionals and policy makers to take actions to mitigate the effect of environmental changes and to adapt to them.

## S02.02F. The Complexity of Microbiomes for Exposure Science

### **S02.02.27. The Built Environment: Why Understanding Microbiology Matters**

Erica Hartmann

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Abstract: We live and work largely indoors and share our indoor environments with an array of microorganisms and microbial products. The microbial communities found in buildings are influenced by a number of factors, including ventilation, humidity, and chemistry, and we help shape these microbiomes through choices about the design, construction, operation, occupancy, and use of our built environments. There has long been interest in how our indoor environments affect health positively or negatively, for example, in the transmission of infectious diseases or in the development of allergic and respiratory symptoms. Research has begun to offer insights into the characteristics of indoor microbial communities-not just which microbes are present but also what they are capable of, particularly with regard to antibiotic resistance-and how these can be affected by interventions. However, what characterizes a "healthy" indoor environment remains largely undefined. The presentation will illustrate examples of recent findings and highlight multidisciplinary collaborative efforts that increase our understanding of these issues. It will provide a perspective on why research that connects microbial ecology, architecture, and environmental and public health will improve the evaluation of how interactions between the built environment and its microbiomes affect us and contribute to a fuller understanding of exposures and health with the long-term aim of improving building design for more healthful environments in the future.

## **S02.02.28. Microbiome Metabolism and Chemical Transformation: How Does the Human Microbiome Change Our Chemical Exposures?**

Andrew Patterson

*Andrew Patterson*<sup>1</sup>

*1. Penn State University, University Park, PA, United States.*

Abstract: The fields of toxicology and xenobiotic metabolism have long recognized the beneficial and sometimes deleterious influence of microbiota in the absorption, distribution, metabolism, and excretion of drugs and toxicants. Early pioneering work with the antibacterial drug prontosil pointed towards the necessity to not only understand the metabolic capabilities of the microbiota but to identify the specific microbiota involved in the generation and metabolism of xenobiotics. However, technological limitations important for cataloging the microbiota community and for understanding or predicting their metabolic capabilities hindered progress. Current advances, including mass spectrometry-based metabolite profiling and culture-independent sequence-based identification and functional analysis of microbiota, have begun to shed light on microbial metabolism. Case studies will be presented to highlight key aspects—for example, microbiota identification, metabolic function and prediction, metabolite identification and profiling—that have helped clarify how microbiota might affect or be affected by xenobiotic metabolism. Lastly, a perspective of the future of this field is presented taking into account what important knowledge is lacking and how to tackle these problems with respect to informing exposure, human health, and disease risk.

## **S02.02.29. The Possible Consequences of Ignoring the Human Microbiome in Health Risk Assessment**

Joseph Rodricks

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Abstract: Emerging research has shown that the microbiome can influence chemical metabolism and absorption and that chemical exposures can perturb microbiome composition and function. Although this research has clear implications for the assessment of human health risks from chemical exposures, risk assessments have not typically incorporated considerations of the human microbiome. Proper characterization of microbial exposures to chemicals would enhance the assessment process. The exposure science community has been relatively silent on chemical-microbiome interactions and their effects on exposure and ultimately risk. As noted in a recent report of the National Academies of Sciences, Engineering, and Medicine, "there is a need to expand the scope of exposure science to incorporate the emerging understanding of the roles of the human microbiome as an agent that influences exposure to and risks posed by environmental chemicals." Examples will be presented to illustrate how the microbiome might modulate the exposure of health risks posed by several environmental chemicals. Major microbiome sites - gut, skin, and respiratory tract - will be highlighted. Opportunities and challenges that might arise in integrating microbiome considerations into exposure science and risk assessment will be discussed.

S02.02G. The Fluoridation Decision: Considering the Evidence for Benefits, Possible Risks as Well as Ethical World Views

**S02.02.31. Ethical World Views and Fluoridation Policy**

Raymond Neutra

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Abstract: A utilitarian world view favors a policy where the accumulated utility from benefits outweighs the disutility of any adverse side effects. A Libertarian Duty Ethics world view opposes any policy that threatens any individual's autonomy. The Libertarian perspective may become more salient if possible adverse effects were found to convey higher risks to vulnerable persons with certain genes. What policies might address both world views?

## **S02.02.32. Evidence About the Benefits of Fluoridation: Caries Prevention Benefits**

E. Martinez-Mier

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Abstract: At appropriate levels, fluoride has been well established as a safe and effective agent in the prevention of dental caries. On the other hand, when individuals are exposed to excessive amounts of fluoride, negative side effects are seen. Despite advances in the reduction of oral diseases, dental caries remains common among both children and adults worldwide, especially among underserved populations in high, middle, and low income countries. Dental caries can negatively affect individuals' overall health and quality of life, and often results in reduced productivity. In addition, its traditional treatment is extremely costly, in both high and low-income countries. While death as a direct result of dental caries remains rare, its presence does result in years lived with disability. This presentation will review the evidence supporting fluoride's role in lowering the prevalence and incidence of dental caries and the preservation of functional dentition as well as good nutrition in late adulthood and how this results in increasing disability-adjusted life years (DALYs). Findings from selected studies on global and national incidence, prevalence, and years lived with disability for dental caries will be reviewed. Trends on the prevalence of dental caries in different segments of the population as well as the number of people with untreated disease will also be presented. The detailed analysis of this evidence will provide background information for an informed discussion on the benefits of fluoridation and any diminution of DALYs from potential adverse side effects.

### **S02.02.33. Neurotoxic Effects of Fluoride Exposures in North America**

Christine Till

*Christine Till<sup>1</sup>*

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Abstract: Fluoride is neurotoxic at exposure levels that exceed maximum intake levels, but less is known about the neurotoxicity of fluoride at 'optimal' levels. Concerns about community fluoridation schemes and adverse health effects are steadily mounting, particularly for vulnerable populations, such as the fetus and young children. There is also concern that the prevalence and severity of dental enamel fluorosis have increased over the past three decades among youth in Canada and the United States. These findings suggest that a fraction of the population experiences excessive intake of fluoride in early development. In 2006, the National Research Council concluded that developmental neurotoxicity may be associated with fluoride exposures given the consistency of available evidence from animal and human studies. However, it has been a public health challenge to reach scientific consensus about what constitutes a safe level of fluoride. This is partly due to the lack of rigorous scientific investigations examining fluoride exposure at critical periods in development and using sensitive endpoints and effective biomarkers of exposure. This presentation reviews recent epidemiologic studies that help to fill in the gap related to detrimental health consequences related to water or salt fluoridation programs. Findings reported in a Canadian and Mexican birth cohort are consistent in showing that higher level of urinary fluoride in pregnancy is associated with lower IQ in offspring. Other adverse effects of fluoride exposure include increased risk of attention deficits following prenatal exposure to fluoride and increased risk of thyroid disruption among iodine-deficient adults. This growing body of evidence linking chronic fluoride exposure to serious health risks beyond fluorosis adds critical new information to the evidence base for informing public health policy.

## **S02.02.34. Possible Benefits and Adverse Effects of Fluoridation in England, 2018 Public Health England Report**

Tony Fletcher

*Tony Fletcher<sup>1</sup>, Giovanni S. Leonardi<sup>1</sup>, David Roberts<sup>1</sup>*

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**Abstract:** The protective effect of community water fluoridation (CWF) on caries has been well demonstrated and relationships with adverse health outcomes have also been alleged. We have recently completed a study of the association between concentrations of fluoride in public water supplies (PWS) and dental caries indicators, as well as several adverse non-dental health-outcomes in England, using recent available routine surveillance data. The methods and results are presented in more detail in other talks at this meeting. The benefits in terms on reduction of caries from CWF are clearly supported by our results, and there was strong interaction with socio-economic status. For example, comparing children in areas with a fluoridation scheme and >0.7mg/l fluoride to low areas with <0.2mg/l fluoride, there are 17% less with caries in the least deprived areas, rising to 28% in the most deprived areas. For non-dental outcomes, we found some associations between fluoride and fractures (adverse) and bladder cancer (protective). However in both cases the pattern of results, especially the lack of a dose response pattern across exposure, suggested a non-causal association. It was concluded that these findings were consistent with water fluoridation being an effective and safe public health measure, in areas with fluoride concentration up to 1 mg/l, to reduce dental caries and reduce dental health inequalities. In reaching this conclusion, the study team balanced both the magnitude of the dental and non-dental effects, and the strength of evidence in terms of internal coherence and consistency with other evidence. Most studies showing adverse effects are at much higher fluoride concentrations and extrapolation to lower concentrations is very uncertain. Some endpoints such as endocrine (thyroid) and neurological (IQ) for exposure up to 1 mg/l could not be addressed in this study, and still need addressing.

## S02.02H. Exploring Current Worker Exposure Tools and their Capability to Support Risk Evaluations of Chemicals Under Amended TSCA

### **S02.02.36. Overview of EPA's Occupational Exposure Tools and Approaches Used in New and Existing Chemical Evaluations Under Amended TSCA**

Nhan Nguyen

*Nhan T. Nguyen<sup>1</sup>*

*1. US EPA, DC, DC, United States.*

Abstract: On June 22, 2016, the Frank R. Lautenberg Chemical Safety for the 21st Century Act was signed into law amending the Toxic Substances Control Act (TSCA), the Nation's primary chemicals management law. The Office of Pollution Prevention and Toxics (OPPT's) risk evaluation addresses occupational settings as part of the exposure assessment. Release to the environment and occupational exposures may be considered simultaneously to gain assessment efficiencies. Key exposure parameters include duration, intensity, frequency and number of workers exposed under the conditions of use of a chemical, and key release parameters may be expressed similarly. Typically, measured data are preferred, but when data are not available, empirical and modeling approaches or assumptions are used. This presentation provides an overview of OPPT's approaches and tools used for assessing occupational exposures and releases of new and existing chemicals with a focus on EPA's computerized tool called Chemical Screening Tool for Exposures and Environmental Releases (ChemSTEER). This tool consists of peer reviewed mathematical models and industry-specific release and exposure scenarios that can be used to estimate exposures and releases in the absence of data and/or to augment available data. Note: The views expressed in this abstract are those of the author and do not represent Agency policy or endorsement

## **S02.02.37. Worker Use Description and Exposure Assessment**

Rosalie Tibaldi

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Abstract: An important component in chemical risk evaluation is to have a common understanding of how substances are used in occupational settings, including work conditions and exposure controls. Identifying every workplace activity and associated condition would result in a large set of highly specific scenarios, each of limited application. An alternative approach is to more generically group tasks when high throughput exposure estimates are desired and conservative models applied. Exposure potential for workers in these respective activities or process types can be linked to emission profiles based on substance physical chemical properties. For example, products containing a moderate volatility solvent applied by hand brush can be expected to result in like inhalation risk under like use conditions, regardless if the product is a paint, adhesive, or cleaning agent. Amended TSCA defines conditions of use as "the circumstances, as determined by the Administrator, under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of." Similarly under REACH use and conditions of use "means any processing, formulation, consumption, storage, keeping, treatment, filling into containers, transfer from one container to another, mixing, production of an article or any other utilization". In modernized countries industrial work environments are likely to have similar operations and worker regulatory protections to prevent exposure. Therefore, exposure evaluation approaches and tools applied to assess substance uses for EU REACH may also be helpful to inform risk evaluations under amended TSCA. This presentation overviews REACH use description for worker exposure assessment and fundamental input parameters used to screen occupational exposure risks. Concepts and approach will be highlighted with an example using the ECETOC targeted risk assessment tool.

## **S02.02.38. Exposure Assessment Tools from the American Industrial Hygiene Association: A Review with Examples of Their Use**

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Abstract: Software tools developed in the AIHA Exposure Assessment Strategies Committee provide ways to statistically evaluate data and evaluate occupational/consumer exposure scenarios. The tools are free and are regularly updated. Several (1 to 3 below) are available in multiple languages. The following five tools will be discussed with examples of their use. IH STAT is an Excel application that calculates a variety of exposure statistics, performs goodness of fit tests, and graphs exposure data. IH MOD is a mathematical modeling Excel spreadsheet suite of 11 algorithms used for estimating air concentration exposures. A new version IH Mod 2.0 additionally provides native in MS Excel Monte Carlo Simulation. IH SkinPerm is also an Excel application for estimating the dermal uptake or evaporation of dermally deposited agents. It also provides estimates of dermal absorption from air. IH Exposure Scenario Tool (IHST) guides evaluation of the workplace, specific scenarios and agents(s), key determinants of exposure and the type of engineering controls. This information is then used with the Qualitative Exposure Assessment Checklist. Qualitative Exposure Assessment Checklist requires: An OEL; the Vapor Pressure of the pure chemical (VP) if in gas or vapor form; the identified workplace controls and the required level of workplace controls. It can be applied in a few minutes using readily available information and has been shown to be more accurate than subjective professional judgments.

## **S02.02.39. Exposure Data Quality Issues and TSCA Assessments**

Judy LaKind

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Abstract: EPA's Federal Register Notice on Procedures for Chemical Risk Evaluation under the Amended Toxic Substances Control Act includes several references to the use of quality assessments for evaluating information and inclusion of quality assessments in systematic reviews. The Notice also points to the importance of using predefined criteria for assessing quality. However, rapid technological advances are producing exposure data for which there are no available data quality assessment tools. While various fields have developed approaches to rigorously and transparently assessing data quality, there is as yet no holistic approach for assessing both measured and modeled data in the context of a fit-for-purpose assessment. Using key elements from existing approaches to assessing exposure data quality, we developed an instrument - ExpoQual - for evaluating the quality of human exposure data that is applicable to both traditional sources of exposure data (the focus here is primarily quantitative measured and modeled data) as well as newer and developing approaches and includes fit-for-purpose considerations. The key strength of ExpoQual is that it facilitates a structured, reproducible and transparent approach to exposure data quality evaluation and forces an explicit determination with regards to fit-for-purpose. The instrument is agnostic regarding whether error introduced by quality issues is systematic (biased in a particular direction) or random and the framework construct does not include data rejection. ExpoQual is designed for development into an online tool; early uses with case studies and feedback from the exposure community will result in an iterative process of instrument advancement. In this presentation we describe the ExpoQual instrument and a case study testing the efficacy of the instrument.

## O02.03A. Air Pollution and Vegetation

### **O02.03.01. Associations of PM2.5 and Out-of-Hospital Sudden Unexpected Death across Strata of Greenspace Metrics and Personal Characteristics**

Kristen Rappazzo

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**Abstract:** Out-of-hospital sudden unexpected deaths (OHSUD) are natural deaths that occur without obvious underlying causes and account for nearly 1 in 6 deaths in the United States. In previous work, we have observed increased odds of OHSUD with (1) increased exposure to PM2.5 in a case-crossover study, and (2) with lower levels of census tract greenway density in an ecological study. Our objective here was to examine potential effect measure modification of the PM2.5-OHSUD association by greenspace metrics and individual characteristics. OHSUD cases in Wake County, NC for March-01-2013 to February-28-2015 (n=399) from the University of North Carolina at Chapel Hill SUDDEEN project, with data on individual characteristics from medical records, were linked to PM2.5, central site from the Air Quality Data Mart, and census tract greenspace metrics, created from the National Land Cover Dataset and county government GIS data. Using a case-crossover design, conditional logistic regression was used to estimate OHSUD ORs (95% CI) for a 5µg/m<sup>3</sup> increase in PM2.5 with a 1-day lag, adjusted for same-day average temperature and relative humidity (both natural splines), across different strata of potential modifiers. Adjusted, unstratified PM2.5-OHSUD OR was 1.18 (0.98, 1.41). For individuals in census tracts with below county median greenway density, the PM2.5-OHSUD OR was 1.38 (1.06, 1.79), while for those in census tracts with above county median greenway density the OR was 1.00 (0.76, 1.31). Individuals with a BMI >30 had an OR of 1.46 (1.01, 2.11), while those with a BMI <30 had an OR of 1.10 (0.88, 1.36). While further investigation is needed due to study size limitations, these results could prove useful for strategies connecting health care practitioners or city planners with information about air quality and factors within the built-environment that foster healthy living. This abstract does not necessarily reflect EPA policy.

## **002.03.02. Associations between Ambient Fine Particulate and Systolic Blood Pressure in Relation to Greenness in the PURSE-HIS Cohort**

Kevin Lane

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**Abstract:** Background Globally, high systolic blood pressure (SBP) is major cause for cardiovascular mortality. Air pollution can adversely affect SBP, while greenness has been shown to improve SBP. Here we assess the association between long-term concentrations of ambient PM<sub>2.5</sub>, SBP and greenness in the Population study of Urban, Rural, Semi-urban Endovascular disease and Holistic Intervention Study (PURSE-HIS) in Tamil Nadu, India. Methods The study included 8080 randomly selected participants (mean age 42 years; 58% women). We used PM<sub>2.5</sub> estimates developed for Global Burden of Disease, which combined satellite-based estimates, chemical transport model simulations, and ground measurements to produce global estimates of annual average PM<sub>2.5</sub> concentrations. We measured greenness using MODIS derived normalized difference vegetation index (NDVI). Brachial BP was assessed in the dominant arm and an average of 3 measurements was used in the analysis. The associations were examined using generalized linear regression models controlling for age, gender, waist circumference, physical activity, sodium intake, smoking, stress, and anxiety. Results The PM<sub>2.5</sub> exposure estimates ranged from 18 $\mu\text{g}/\text{m}^3$  to 35 $\mu\text{g}/\text{m}^3$  in the study area. In independent multivariate models an IQR increase in PM<sub>2.5</sub> (3.0  $\mu\text{g}/\text{m}^3$ ) was associated with a 5.5 mmHg (95%CI: 4.9, 6.2) change in SBP. Stratification of participants by tertiles of NDVI showed markedly higher association of PM<sub>2.5</sub> with SBP when comparing those residing in low NDVI areas (5.0 mmHg [95%CI: 3, 6.9]) to those in medium (3.7 mmHg [95%CI: 2.8, 4.6]) and high NDVI areas (1.1 mmHg [95%CI: -0.6, 2.8]). Conclusions PM<sub>2.5</sub> was associated with SBP independently, with significant modification of this association by greenness with the largest PM<sub>2.5</sub> associations in the lowest tertile of greenness. Further studies are required to assess interaction between PM<sub>2.5</sub> and greenness on other biomarkers of cardiovascular health.

### **002.03.03. The Effect of Particulate Air Pollution on Hospitalization and Effect Modification by Green Space**

Seulkee Heo

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**Abstract:** Although benefits of greenness promoting physical activities and reducing air pollution have been suggested, studies examining the modifying effect of greenness on the relationship between short-term exposure to air pollution and morbidity risk are scarce. We quantified health benefits of green space for reducing the risk of hospitalizations due to particles (PM10 and PM2.5) in urbanized U.S. counties for 2000-2013. Normalized Difference Vegetation Index (NDVI), which ranges from -1 to 1 with higher values indicating larger density of vegetation, was used as a proxy of greenness. We used time-series analyses and meta-regression to calculate overall impact of air pollution on hospitalization aged 65 years and over for various diseases across 364 counties. Meta-regression models quantified the changes in the county-specific risks of hospitalization explained by the county-level average NDVI controlling for socio-economic factors. The effect modification of NDVI by 0.1-unit change (5% of the range of index) was quantified as percent change in the number of hospital admissions associated with a 10-unit increase of fine particles. On average across the counties, all study diseases showed significant increases in the rate of hospital admissions with PM2.5 and some diseases with PM10. Range of the NDVI effect modification in the form of percent change in cause-specific hospitalizations associated with a 10  $\mu\text{g}/\text{m}^3$  increase in particles was -7.1% to 3.8% for PM10 and -0.6% to 0.1% for PM2.5. The estimates were significant for ischemic heart (-7.1%) disease and all respiratory diseases (-1.1%) associated with PM10. The results comparing sex and age showed significantly higher NDVI effect modification for reducing the risks of stroke associate with PM10 and PM2.5 for men and younger patients. Our results identified the health benefits of community-level greenness for reducing the health burdens of hospitalizations due to air pollution in the elderly population in urban areas.

#### **002.03.04. Relationships between Greenness and Low Birth Weight: Investigating the Interaction and Mediation Effects of Air Pollution**

Jun Wu

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**Abstract:** This large population-based study investigated the relationships between low birth weight (LBW, <2,500 gram) in term born infants ( $\geq 37$  gestational weeks), residential greenness, and the potential influence of air pollution in these relationships (joint effect, mediation) using data from 2001-2008 birth certificate records in California. Residential greenness was assessed by the Normalized Difference Vegetation Index (NDVI) within circular buffers surrounding maternal homes; while complementary indicators of air pollution exposure were estimated for the major air pollutant components (i.e. PM<sub>2.5</sub>, NO<sub>2</sub> and O<sub>3</sub>). Multi-level Poisson regression was applied with random effect at the hospital level and adjusted for potential confounders. We investigated associations between greenness and LBW within different population subgroups including urban/rural areas and different socioeconomic (SES) levels. We investigated the potential effect measure modification of air pollution on both additive and multiplicative scales. We also conducted mediation analysis, using a product of coefficients method, in order to quantify the contribution of local air pollutants abatement or increase due to greenness on LBW. In total, 72,632 singleton LBW cases were included. We observed a reduction of LBW risk associated with an increase in residential NDVI. This association was only observed in urban areas and was strongest in populations with the lowest SES levels. No interaction (neither additive nor multiplicative) was observed between NDVI and air pollution on LBW risk. The mediating effect of PM<sub>2.5</sub> in the impact of greenness on LBW was 16.7%. We provided empirical evidence for reduced risk of term LBW associated with maternal residential greenness, particularly on urban areas and among low SES women. Air pollution does not appear to modify this association but we found that a pathway in which greenness benefits to LBW is through a local reduction in air pollution.

## **O02.03.05. The Relationship between Long-Term Exposure to Neighbourhood Greenness and Air Pollution and Cardiovascular Mortality in Urban Areas in Belgium**

Mariska Bauwelinck

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**Abstract:** Background Few large-scale studies have evaluated the association between residential green, air pollution and cause-specific mortality. Our study investigates the relationship between long-term residential exposure to green spaces, air pollution and cardiovascular (CV) mortality in adults living in the five largest cities in Belgium. Methods We used the Belgian 2001 census linked to mortality follow-up data (2001-2011) among 18 to 65-year-old adults for the 5 largest cities in Belgium. The data contain individual information on CV mortality (ICD-10 codes I10-I70), sociodemographic variables (age, sex, education level, employment status and housing status), residential history (based on the link with the 1991 census) and annual means ( $\mu\text{g}/\text{m}^3$ ) of air pollution (PM10, PM2.5, NO2 and BC) for the residential addresses. Different measures of green (percentage (+ 600m buffer), proximity and fragmentation of green) based on land use data (CORINE land cover) were available at the scale of census tracts. Cox proportional hazards models, where age was used as the underlying time scale, were performed to probe into CV mortality. Results We studied  $\approx 2$  million adults with 10.25 years of follow-up and observed  $\approx 11,200$  CV deaths. Consistent statistically significant effects were found for the different measures of green in the adjusted models. Hazard ratio's for the % of neighbourhood green per increase in IQR and % of green within a 600m buffer were 0.969 (99% CI 0.952-0.987) and 0.866 (99% CI 0.830-0.905), respectively. Results show independent effects for the measures of green on CV mortality when adjusted for the different pollutants separately. Sensitivity analyses including only non-movers showed similar results. Conclusion Our results suggest a beneficial association between exposure to residential green and CV mortality. Further analyses will be conducted within this study to confirm our results.

## **O02.03.06. Using Mobile Technology to Understand Local Environmental Factors Associated with Symptoms of Asthma and Allergic Rhinitis**

Fay Johnston

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**Abstract:** BACKGROUND: AirRater is a smartphone application that tracks symptoms, air quality, weather and pollen. We aimed to identify the most important environmental factors associated with symptoms of allergic rhinitis and asthma among app users in three geographic regions of Tasmania, Australia. METHODS: We analysed daily symptom reports relating to the eyes, nose and lungs, with measures of particulate matter (PM<sub>2.5</sub>), pollen from locally abundant taxa, temperature, humidity, and rainfall from September 2015 through July 2017. We implemented separate negative binomial regression models for each region, adjusting for time trends, seasonal cycles, and fluctuations in the number of active app users through time. RESULTS: 3,443 individuals, 84% of whom reported having either asthma or allergic rhinitis, provided 12,396 symptom reports during the study. 74.5% of these related to the nose or eyes and 26.5% to the lungs. Associations with environmental predictors were similar across the three regions. In the largest region of Hobart, total combined symptom reports increased in association with daily PM<sub>2.5</sub> (IRR 1.05 95%CI 1.03 - 1.07) per 10µg/m<sup>3</sup>, maximum temperature (IRR 1.032 95%CI 1.014 - 1.050) per degree, and relative humidity (IRR 0.93 95%CI 0.87 - 0.98) per 10% increase. Symptoms were also strongly associated with tree pollen concentrations, especially Betula (Birch) (IRR 1.08 95%CI 1.02 - 1.15), Cupressaceae (Cypress) (IRR 1.04 95%CI 1.01 - 1.07), and Dodonaea (Hop bush) (IRR 1.01 95%CI 1.00 - 1.03) per 10 grains/m<sup>3</sup>. Associations with individual symptoms of the nose, eyes and lungs were generally consistent for air quality and meteorological variables. There was greater variation between lung, eye and nose symptoms and pollen concentrations for several plant taxa. CONCLUSIONS: App-based symptom data is a promising source of information for understanding the environmental determinants of day-to-day symptoms in people with asthma and allergic rhinitis.

## O02.03B. Effects of Temperature 1

### **O02.03.07. Modeling Temperature-Related Mortality Using Nonlinear Autoregressive Models with Exogenous Input**

Cameron Lee

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Abstract: Various modeling methodologies have been used to examine the time-lagged and nonlinear relationship between weather and human mortality. One emerging modeling framework in various environmental fields is an artificial neural network-based time series model known as nonlinear autoregressive models with exogenous input (NARX models). The objectives of this research were to demonstrate the utility of NARX models to the environmental epidemiology research community via an investigation of temperature-related mortality. Comparisons with the commonly-used distributed lag nonlinear model (DLNM) are also presented. Minimum and maximum daily apparent temperatures and daily all-cause mortality data were collected for 41 different US cities, 1979-2010. NARX models were trained to predict daily mortality from 60% of the data in each city, while 20% of data was held out for both internal validation and independent external testing. Model performance varied by location and season, with the highest performance generally coming in populous cities and the winter season. Across the US as a whole, median absolute percentage errors were 10.2% and the models improved the explained variance over that of a simple persistence model by 18 percentage points. Top quintile spike days in mortality were also skillfully predicted 54% of the time, with some locations correctly modeling over 70% of these spikes. NARX comparisons with DLNMs revealed nearly identical time-lagged relationships, largely in agreement with previously published research. These results exhibit the ability of NARX models in predicting complex, time-dependent relationships that could be useful for diverse applications in epidemiological research.

## **002.03.08. Multiple Determinants of Vulnerability for Emergency Department Visits for Heat-Related Illness in California 2005-2008 Warm Seasons**

Helene Margolis

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**Abstract:** Background: High temperatures are associated with risk of Heat-Related Illness (HRI) and other acute clinical outcomes. Information on HRI risk factors is rarely place-based; decision-makers need local-scale (e.g., neighborhood) data to inform strategies to reduce heat health impacts. Objective: In multi-determinant multi-level models assess relations between daily maximum temperature (Tmax) and emergency department (ED) visits for HRI and vulnerability factors, i.e., biological susceptibility (e.g., sex, age, race), physical environment (e.g., land-use, air quality), or socioeconomic (e.g., neighborhood assets). Methods: CA Office of Statewide Healthcare Planning and Development ED data for 2005-2008, restricted to the warm seasons (May 1-October 31) were used. Cases were defined as a HRI diagnosis (International Classification of Diseases (ICD) ninth revision, clinical modification (ICD9-CM) code 992.0-992.9). Non-HRI cases were retained as controls. Exclusions: If date of visit or residence ZIP code (ZC) was missing. ZC were converted to Zip Code Tabulation Area (ZCTA) to link census tract data to patients. Hierarchical generalized linear models with a logit link (SAS v9.3 PROC GLIMMIX) were used. For each exposure (daily Tmax, daily O3 or PM10) models included both the ZCTA-specific 4-year seasonal mean (Tmaxmn), and ZCTA-day (i.e., ED visit date) deviation from that mean (Tmaxdif). Interaction terms were used to evaluate effect modification. Results: HRI risk was positively associated with Tmaxdif (OR 1.02 95%CI: 1.016, 1.019, p<.0001), and co-exposure to O3 (Tmaxdif\*O3dif) increased the risk (OR 1.051 95%CI: 1.043, 1.059, p<.0001). Risk varied by age group, sex and race/ethnicity, with girls (especially those ≤ 10 years), African American and Hispanic children, and elderly Black at greatest risk. ZCTA %-impervious surfaces, % multi-family homes were positively associated with HRI. These and other results pointed to interventions to reduce HRI risk.

## **O02.03.09. The Relationship between Extreme Heat and Cardiovascular Mortality: Assessing Effect Modification by Social Vulnerability Metrics**

Ambarish Vaidyanathan

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Abstract: Heat-Mortality relationships show heterogeneity across populations; however, extant literature sheds little light on the factors, especially social determinants of health, responsible for this differential heterogeneity. Our objective was to assess the effect modification by social vulnerability metrics (SVMs) on the association between heat and mortality. A two-stage time-series analysis with distributed lag non-linear models was used to model the exposure-response (E-R) relationships between heat and mortality in 2,431 counties in the United States for years, 2001-2012. The risk estimates were pooled in a meta-regression framework to examine how SVMs modified the E-R relationships. A counterfactual health burden analysis was applied to quantify the extent of the effect modification by estimating fractions of deaths attributed to heat (AF) at various percentiles of each SVM. The SVMs used in this assessment ranged from commonly used sociodemographic variables to a composite community-specific Heat-Related Social Vulnerability Rating (HRSVR). The HRSVR and several SVMs, including socioeconomic status (e.g., % with no high school diploma), housing (e.g., % of households with no vehicles), and minority status (e.g., % of population with limited English speaking abilities) variables were significantly associated with an increase in heat-attributed mortality. Across all climate regions, the increase in AF of deaths for an interquartile increase in HRSVR levels was 0.59% (95%CI: 0.55%-0.63%). Health burden is likely to increase with increasing social vulnerability levels and the extent of effect modification varies with SVMs. The results from this assessment could potentially be used to identify at-risk areas based on their levels of social vulnerability and design community-specific heat intervention plans to help prepare for extreme heat emergencies.

## **O02.03.10. Nonparametric Bayesian Multivariate Meta-Regression with Functional Meta-Predictor: An Application in the Temperature-Mortality Study**

Yeonseung Chung

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**Abstract:** Background/Aim: Time-varying temperature-mortality association has been reported in numerous research, but little is known about the time-varying predictors that may underlie the changing association. Multivariate meta-regression has been used in the temperature-mortality study to combine evidences from multiple locations with meta-predictors incorporated. However, the current form of meta-regression is limited as it does not incorporate time-varying meta-predictors. Methods: We introduce a nonparametric Bayesian multivariate meta-regression incorporating functional meta-predictors to estimate the temperature-mortality association changing over time and identify the time-varying predictors related with the temporal changes. Our modeling framework is a two-stage approach; the first stage uses the time-varying distributed lag nonlinear model to estimate the time-varying association for each location, and the second stage pools the location-specific time-varying associations incorporating time-varying meta-predictors. For the second stage, we formulate a nonparametric (np) Bayesian multivariate meta-regression, which identifies clusters based on both the time-varying associations and the overtime trajectory of meta-predictors. Our method was applied to the daily time series data of temperature and mortality collected for 47 prefectures in Japan for 1972-2012. The prefecture-specific yearly air conditioning (AC) prevalence was used as a time-varying meta-predictor. Results: Results indicated that there are two major clusters; cluster 1 showed the clearly decreasing heat-related mortality over time with a sharply increasing AC curve, cluster 2 showed the slowly decreasing heat-related mortality over time with a gradually increasing AC trajectory. Conclusions: Our proposed method is a promising statistical approach for exploring the influence of functional meta-predictors on an exposure-response association characterized complexly by multiple parameters in meta-analysis.

### **O02.03.11. Comparison of Temperature-Mortality Associations Estimated with Point-Based Temperature Observations Versus Spatially-Resolved Temperature Estimates**

Kate Weinberger

*Kate R. Weinberger<sup>1</sup>, Keith Spangler<sup>1</sup>, Antonella Zanobetti<sup>2</sup>, Joel D. Schwartz<sup>2</sup>, Gregory A. Wellenius<sup>1</sup>*

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**Abstract:** Background: Studies of the association between ambient temperature and mortality typically rely on temperature observations from a single weather station to estimate the exposure of people living across large areas. Spatially-resolved temperature estimates may reduce exposure measurement error in locations where available weather stations are sparse or do not fully capture the exposure of the population of interest. Objective: To quantify the association between daily mean temperature and mortality in 20 large United States (US) cities, using (1) temperature observations from the airport weather station closest to each city, and (2) population-weighted temperature estimates constructed from PRISM, a high-resolution, gridded meteorological dataset. Methods: For each temperature data source and in each city, we used distributed lag non-linear time series models to estimate the 21-day cumulative association between daily mean temperature and all-ages mortality counts, controlling for seasonal and long-term trends, day of week, and federal holidays. We additionally calculated the fraction of deaths attributable to hot and cold temperatures. Results: Associations estimated using the two temperature data sources were similar in most cities. For example, in New York City, the rate ratio comparing the 99th percentile of temperature to the minimum mortality temperature was 1.25 (95% CI: 1.18, 1.32) for observed temperature and 1.27 (95% CI: 1.20, 1.34) for estimated temperature. A limited number of cities showed disparate results. Across all 20 cities, we estimate that 0.5% (95% eCI: 0.3, 0.7) and 0.6% (95% eCI: 0.4, 0.7) of deaths were attributable to heat when using observed and estimated temperature, respectively. Conclusions: On average across 20 US cities, observed and estimated temperatures yielded similar relative and absolute measures of mortality risk. Gridded datasets may be particularly advantageous in the context of populations without reliable weather observations.

### **O02.03.12. Is Temperature Linked to Mortality and Hospitalizations in Africa Settings?**

Margarita Triguero-Mas

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**Abstract:** Although many studies have indicated that extreme temperatures may increase mortality, there is paucity of information on hospitalizations and climate-health relationships in Africa. To address these shortfalls, we assessed the association between temperature and mortality and hospitalizations in Mozambique. We also investigated whether these relationships differed by population and diagnose subgroup. We used data from a cohort study established at the District of Manhica (Mozambique). We obtained sociodemographic and mortality data from all the population and hospitalizations data from those 15 years old or younger for the period 1996-2017. Data on temperature were derived from NASA's Modern-Era Retrospective Analysis for Research and Applications (MERRA) model. We fitted quasi-Poisson time series regression models for each health outcome with temperature as an independent variable. There was a mean incidence of 3 deaths and 3 hospitalizations daily. Coinciding with a big flood, higher incidences occurred on 2000 and 2001. Decreases on mortality and hospitalizations from 2014 onwards concurred with health services improvements in the area. There was a significant association between mortality and hospitalizations and the climatic variables in Manhica. Accumulating all the three evaluated lags, for extreme cold (i.e. 2.5th percentile) the mortality relative risk, RR, was 1.07 (95% CI:1.01, 1.13), while for extreme heat (i.e. 97.5th percentile) it was 1.25 (95% CI: 1.08, 1.44). In the case of hospitalizations, for extreme cold RR was 1.96 (95% CI: 0.89, 4.34) and for extreme heat it was 2.12 (95% CI: 0.95, 4.75). Our analyses by subgroups only showed small differences on the mortality by age group. Most of the temperature-related health outcomes were attributable to contributions of heat. This evidence has important implications for the planning of public-health interventions, especially when taking into account future effects of climate change.

## 002.03C. Exposure and Health Effects Related to Waste

### **002.03.13. Relationship between Blood Lead Levels and Dietary Essential Mineral Intake in Electronic Waste Workers and a Control, in Ghana**

Sylvia Takyi

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**Abstract:** Background: Several toxic metals are known to interact with, and affect absorption of micro nutrients in the gastro-intestinal tract. Although studies have reported high levels of lead (Pb) in electronic waste (e-waste) workers, the possible interaction and impact on availability of essential minerals in the body have not been extensively studied. Objectives: The aim of this study was to investigate the relation between blood lead levels (BLL) and dietary essential mineral (Ca, Fe, Mg, Zn, Cu) intakes of e-waste workers and a control group. Methods: This prospective cohort study, which is part of the ongoing West Africa GEOHealth II project, compared 100 e-waste workers at Agbogbloshie (exposed) to 50 controls (unexposed). 10 ml of whole blood was collected and analyzed for Pb using the Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Essential mineral intakes were assessed using a 2 day 24 hour recall and analyzed by the Esha F-Pro nutrition software. Statistical analysis was done using SPSS (Version 22). BLL and essential minerals were reported using means, standard deviations (SD) and ranges. Results: Overall, mean (SD) BLL was higher ( $9.24 \pm 6.37 \mu\text{g/dL}$ ) in e-waste workers, range (2.42-41.60  $\mu\text{g/dL}$ ) than the control group ( $4.10 \pm 1.92 \mu\text{g/dL}$ ), range (1.51-14.04  $\mu\text{g/dL}$ ). BLL levels were mostly above 10  $\mu\text{g/dL}$  at e-waste site (28%), compared to control site (2%). Mean intakes of Ca, Zn, Cu and Mg in the diet were low in both groups, but Fe was adequate. A simple linear regression model showed a positive relationship between BLL and Ca intake ( $r = 0.39$ ,  $p < 0.001$ ). Conclusions: Diet taken lacked adequate levels of Zn, Cu and Mg among all study participants. There was a positive relationship between Ca levels and BLL. This preliminary data suggests the need to supplement existing dietary intake with certain micronutrients. Key Words: Essential minerals, Lead, Whole Blood, E-waste, Ghana

## **002.03.14. Mercury Exposure: Impact on Birth Outcomes in Suriname**

Renske Wouters

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**Abstract:** Background Small-scale gold-mining operations in Suriname use mercury (Hg) for gold extraction. Exposure during pregnancy can negatively influence birth outcomes and neurodevelopment. The Caribbean Consortium for Research in Environmental and Occupational Health is assessing exposure to metals in 1000 mother/child dyads. This study evaluates the association between Hg exposure in pregnant women and birth outcomes. Methods Hair samples were analysed for total Hg and associated with birth outcomes collected from parturition books and clinical records. Adverse birth outcomes included stillbirths, congenital anomalies, low APGAR score at 5 minutes (<7), low birth weight (<2500g), and preterm birth (<37 weeks). Logistic regression analysis was used to determine the association between hair Hg levels (high Hg was defined as exceeding the 1.1 µg/g USEPA action level) and adverse birth outcomes. Results Preliminary data showed a median [Hg] in hair of 246 women was 0.64 µg/g (range < LOD-6.86 µg/g; IQR 0.39-1.07), 60 women (24.4%) exceeded 1.1 µg/g. In multivariable logistic regression analysis women with lower secondary education or less had a high [Hg] compared to women with higher secondary education and up (OR 2.84; 95%CI 1.50-5.39; p=0.001). Women of Asian descent had an [Hg] comparable to those of African descent (p=0.096). Overall 24.1% of women had adverse birth outcomes, 28.3% in women with high [Hg] vs. 25.3% with low [Hg] (p=0.638). Conclusion One out of 4 pregnant women in Suriname had hair Hg concentrations that exceeded the USEPA action level. Adverse birth outcomes were not influenced by high Hg levels. Remarkably, lower educated women showed high Hg levels, warranting further investigation. This dataset was mainly limited to women from Suriname's coastal area. Including more women from the interior, who are expected to be more severely exposed, may alter the effect of Hg on birth outcomes. Funding FIC/NIH U01TW010087-01, U2RTW010104

## **002.03.15. Occupational Exposure to Flame Retardants among Canadian E-Waste Dismantlers**

Victoria Arrandale

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**Abstract:** Background: The mass of e-waste produced globally is growing dramatically. Workers dismantling and recycling e-waste are exposed to many hazards, including flame retardants (FRs), that are added to electronics to meet flammability standards. Environmental exposure to FRs is ubiquitous and has been associated with adverse health effects including endocrine disruption (thyroid hormone dysregulation), neurological impairments and reproductive effects. This study reports on occupational FR exposure in an Ontario, Canada e-waste dismantling facility. Methods: Sampling was conducted daily over a total of five days in February 2017 in Ontario, Canada. Twenty active air samples were collected at 4 workbenches. Ten active air samples were collected over 24 hours at a central workplace location. Seven floor and 8 workbench dust samples were also collected. Samples were analysed for novel brominated flame retardants (NFRs), polybrominated diphenyl ethers (PBDEs) and organophosphate esters (OPEs), using gas chromatography mass spectrometry (GC-MS). Results: The most abundant FRs in air were the now-banned PBDEs, dominated by BDE-209 with an average concentration at the workbenches of 175 versus 108 ng/ m<sup>3</sup> at the central location ( $p < 0.05$ ). Air levels of BDE-209 were almost 5 times higher than in an earlier study in Sweden (Sjodin et al, 2001). The next most abundant compounds were TDCPP and TCCP, two OPEs. Levels of FRs in air and dust did not differ between floor and workbench. In dust, BDE-209 was the most abundant compound, followed by TPHP and TDCPP. Conclusions: Levels of FRs in air and dust collected from this Canadian e-waste recycling facility indicate that e-waste dismantlers in Ontario, Canada have inhalation exposure to FRs. Skin exposure and ingestion through hand-mouth contact are also potential routes of exposure. Though there is evidence of FR toxicity, there are no occupational limits in Canada which is a significant gap given the potential for elevated exposure.

## **002.03.16. Environmental Exposures and Asthma in Women Living in Rural Costa Rica: Results from the ISA Study**

Brooke Alhanti

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**Abstract:** Background: Environmental exposures are contributors to respiratory disease around the world. Pesticide and waste burning exposure may contribute to adverse respiratory outcomes in rural areas. To evaluate the impact of environmental exposures on respiratory health, we studied women in the Infants' Environmental Health Study (ISA), a prospective cohort study of women and children living in the banana-growing region of Costa Rica. Methods: We collected information from women on respiratory outcomes (asthma symptoms and diagnosis) using the European Community Respiratory Health Study questionnaire, height, weight, and environmental exposures, and obtained a urine sample for pesticide analysis. Urine samples were analyzed for the pesticide metabolites 3,5,6-trichloropyridinol (TCP) for chlorpyrifos; dimethylcyclopropane carboxylic acid (DCCA) and 3-phenoxybenzoic acid (3-PBA) for pyrethroids; and 5-hydroxythiabendazole (OHT) for thiabendazole. For each analyte, we dichotomized the exposure measurement at the 75th percentile. We used questionnaire data to calculate an asthma score, which helps to identify untreated, symptomatic asthma. We performed a cross-sectional analysis, using logistic regression adjusted for BMI to identify environmental exposures related to asthma score and asthma diagnosis. Results: Among the 273 women, 21% reported doctor diagnosis of asthma and 39% had an asthma score consistent with asthmatic symptoms. Self-reported doctor-diagnosed asthma was associated with 3-PBA (OR=1.64, 95% CI: [0.85, 3.09]), whereas asthma score was associated with OHT (OR=1.63, [0.93, 2.85]). Asthma score was also associated with residential exposure to air pollution due to burning (OR=2.03, [1.01, 4.32]). This association was stronger with more frequent exposure to waste burning - daily exposure was more likely to lead to a high asthma score than rare exposure (OR=2.31, [1.03, 5.28]). Conclusion: Environmental exposures may contribute to respiratory symptoms in women.

## **002.03.17. Birth Outcomes Associated with Maternal and Fetal Exposure to Metals from Informal Electronic Waste Recycling in Guiyu, China**

Stephani Kim

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Abstract: Informal electronic waste (e-waste) recycling is a rapidly growing industry in developing countries, as ~50 million metric tons of e-waste are generated annually. Informal e-waste recycling creates widespread environmental contamination of a mixture of chemicals. The E-waste Recycling Exposure and Community Health (e-REACH) study enrolled pregnant women in Guiyu, an informal e-waste recycling site (n=314), and Haojiang, an unexposed control site, (n=320) at delivery. We analyzed maternal blood, cord blood, and maternal urine for lead (Pb), cadmium (Cd), chromium (Cr), and manganese (Mn). We also captured data in newborns on birth weight, birth length, head circumference, body mass index (BMI), and Ponderal Index (PI). We calculated the geometric mean (GM) for each metal and calculated the ratio between sites using generalized linear models. We ran linear regression models to compare the birth outcomes between sites after adjusting for maternal age, education, occupation, BMI, gravidity, exposure to environmental tobacco smoke, and newborn sex. Maternal blood Pb, Cd, and Cr were higher in Guiyu compared to Haojiang, with a GM of Pb at 6.66 µg/dL (range: 1.87 - 27.09 µg/dL) and was 1.74-fold greater than in Haojiang (95% CI: 1.60, 1.89). Pb in cord blood was 1.53-fold higher in Guiyu (95% CI: 1.38, 1.68). Urinary Cd (2.15, 95% CI: 1.72, 2.69), Cr (1.63, 95% CI: 1.09, 2.45), and Mn (2.04, 95% CI: 2.04, 3.31) were also significantly higher in Guiyu compared to Haojiang. Guiyu neonates had significantly smaller head circumference ( $\beta$ : -1.58 cm, 95% CI: -2.03, -1.13), BMI ( $\beta$ : -0.75, 95% CI: -1.11, -0.38), and PI ( $\beta$ : -1.91 kg/m<sup>3</sup>, 95% CI: -2.98, -0.84). Birth weights were also lower in Guiyu ( $\beta$ : -41.98 g, 95% CI: -135.96, 51.9). We observed differences in the head size and Ponderal Index of neonates from Guiyu when compared to neonates from Haojiang. Since e-waste exposure is a complex mixture, the outcomes could be related to additional chemicals and interactions.

## **002.03.18. Ethical Aspects in the Assessment of Exposure and Health Effects Related to Waste**

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Abstract: Papers on site contamination, air monitoring and biomonitoring related to waste are presented. Exposure includes lead (Pb) soil contamination, flame retardants (FR) and metals in electronic waste dismantlers, mercury (Hg) from gold mining, and pesticide metabolites in people. Outcomes are various birth outcomes and asthma. Accuracy in measuring exposure and outcome is essential for a correct interpretation of results. Exposure assessment in non-biota (here Pb in soil, FR in air and dust) might meet a methodological and ethical challenge in evaluating accuracy and interpretation in relation to health when communicated to the exposed people. Biomonitoring needs informed consent, interpretation of results, and a communication plan. Biomonitoring of substances not having well-established toxicological effects at low levels (here FR), meets certain challenges in interpretation of data, bearing in mind statistical power, uncontrolled confounding and limitations using a cross-sectional design. Biomonitoring of substances prevalent both in occupational and environmental settings sets an ethical challenge when communicated to employers and policy makers. Studies of birth outcomes include exposure to fetuses. Protecting the most vulnerable, including the fetus, not able to advocate for themselves, is a first-order principle of biomedical ethics. Another first-order principle of bioethics is that research should avoid harm to the individuals and to the communities studied. Is there a risk of unintentional harm to the population if a study is statistically under-powered and, hence communicated as safe? What ethical considerations are needed when communicating results from occupational exposures when there are no occupational limits? Risk communication and management plans are needed to fulfill the obligation of transparency to the study population. These questions will be addressed in the ethics discussion.

O02.03D. Exposure Assessment, Susceptibility, and Demographic Factors in Studies of Air Pollution Mediated Mortality

**O02.03.19. Refined Estimates of PM2.5 Exposure and Associated Mortality Burden Using Mobile Phone Big Data**

Jiongchao Ding

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**Abstract:** Introduction: The improvement of transportation infrastructure, especially the development of high-speed trains, has greatly stimulated the increase of population mobility. Based on census data, existing studies have attempted to quantify the long-term trends of population migration and the consequent environmental impacts. This, however, captured only a small part of population mobility. It ignored the short-term mobility across scales of weeks, days, or even hours, and consequently introduced significant biases in assessing PM2.5 exposure and associated mortality burdens. Methods: In this context, the geographically and time-referenced Call Detail Records (CDRs) makes it possible to address the issues we mentioned above. So in this study, we extracted hourly spatialized population density maps in Jiangsu Province from the CDRs of about 40 million mobile phone users in over 310 thousand macro cells. Based on this Dynamic Population Distribution (DPD), as well as spatiotemporal PM2.5 concentration levels and localized PM2.5 doses-response relationship, we used the Relative Risk Model to evaluate the population-weighted PM2.5 attributed deaths. Finally, Mann-Whitney U Tests were carried out to assess the statistical difference of PM2.5 exposures between DPD and Static Population Distribution (SPD), between daytime and nighttime, and between workdays and weekends. Results and Discussion: The results show that significant difference ( $p < 0.05$ ) existed between DPD and SPD. In investigating the temporal variation of population-weighted PM2.5 attributed deaths under DPD, significant difference ( $p < 0.05$ ) between daytime and nighttime can also be found in most of the areas in Jiangsu Province. The difference shows that when more detailed information is included, results from the traditional method may be challenged. The introduction of CDRs data can help us minimize the uncertainties and provide better information for the development of mitigation and adaption strategies.

## **O02.03.20. A Marginal Estimate of PM2.5 Effects on Mortality Using Propensity Scores and Exposure Randomization by Moving**

Yara Abu Awad

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**Abstract:** Introduction: Multiple observational studies have found an association between ambient PM2.5 and mortality, and while they all adjusted for confounding, inferring causality is always challenging. In this study, we leverage information on changing residential address (moving) to design an observational study that will be less sensitive to confounding bias. Methods: In the Medicare cohort aged 65 and older, we identified about 10 million movers and 52 million non-movers and then used a previously validated exposure prediction model to assign mean annual PM2.5 exposure. We checked if moving randomized subsequent exposure by comparing the standardized differences in confounders by exposure in movers to non-movers. We controlled for potential individual and ecological confounders and Zip code of origin using propensity score models to generate inverse probability weights (IPWs) among white and black movers separately and applied these weights in Cox proportional hazards models to estimate the risk of all-cause mortality. Results: All standardized differences were smaller among white movers compared to non-movers indicating randomization to exposure. Among black movers, all standardized differences were smaller except for Medicaid eligibility and % home ownership at the Zip code level (these differences were slight). Using our IPWs, per 10  $\mu\text{g}/\text{m}^3$  of PM2.5 exposure we found a hazard ratio of 1.15 (95% CI: 1.14 to 1.16) among whites and 1.23 (1.21-1.26) among blacks. Hazard ratios held even when restricting these analyses to movers exposed to levels below the current US EPA standard of 12  $\mu\text{g}/\text{m}^3$ . Conclusion: We used a pseudo-randomization approach (moving) to obtain protection against unmeasured confounders combined with a propensity score approach, which makes exposure independent of measured covariates, and found a highly significant effect of PM2.5 on death rates, which is likely causal and continues below current standards.

### **O02.03.21. The Concentration-Response between Long-Term PM2.5 Exposure and Mortality: A Meta-Regression Approach**

Alina Vodonos Zilberg

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Abstract: Long-term exposure to ambient fine particulate matter ( $\leq 2.5 \mu\text{g}/\text{m}^3$  in aerodynamic diameter; PM2.5) is significantly associated with increased risk of premature mortality. We provide an updated meta-analysis of all-cause and cause specific mortality associated with exposure to PM2.5 as a function of air pollution levels. We systematically searched all published cohort studies examining the association between long-term exposure to PM2.5 and mortality. We applied multivariate linear random effects meta-analysis with nested structure for cohort and study as random effects. Meta-regression techniques applied to test whether study population or analytic characteristics modify the PM2.5 -mortality association and to estimate the shape of the concentration-response curve. A total of 53 studies (39 from North America, 8 from Europe, and 6 from Asia) that provided 135 estimates of the association between the risk of mortality and exposure to PM2.5 were included in the meta-analysis. Since 2015, 17 new studies have been published, covering geographic areas with a wider range of mean exposures (e.g.  $<12$  or  $> 20 \mu\text{g}/\text{m}^3$ ). A penalized spline showed the slope decreased at higher concentrations but appeared to level off. We found that the inverse transform of average PM2.5 well approximated that spline and provided a parametric estimate that fit better than a linear or logarithmic term for average PM2.5. In addition, we found that exposure assessments using space time models or fixed monitors at Zip-code scale, or additionally controlling for area level socio-economic status were associated with higher effect estimates. This meta-analysis provides a strong evidence for the adverse effect of PM2.5 on mortality, that studies with poorer exposure have lower effect size estimates, and that more control for SES increases effect size estimates. The concentration -response function produced here can be further applied in the global health risk assessment of air particulate matter.

## **O02.03.22. Long-Term Exposure to Air Pollution and Mortality among People with and without Diabetes and Asthma or COPD**

Nicole Janssen

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**Abstract:** Introduction the association between long-term exposure to air pollution and increased risk of mortality has been well documented. However, less is known about the populations most susceptible to these effects. We evaluated the associations between long-term exposure to air pollution (PM<sub>2.5</sub>, NO<sub>2</sub> and EC) for people with and without diabetes and asthma or COPD. **Methods** We linked modelled annual average concentrations of PM<sub>2.5</sub>, NO<sub>2</sub> and EC of the year 2008 to a registration based cohort of 7.5 million Dutch residents 30 years or older, with follow-up for five years (2008-2012). We used data on individual medication prescriptions in the two years before baseline (2006+2007) to define subpopulations with and without diabetes, and with and without asthma or COPD. We used cox proportional hazard models to estimate Hazard Ratios (HR), adjusting for individual and area-level confounders. We stratified by disease status to compare risks for the different subpopulations. **Results** We identified 527 thousand cohort members with asthma or COPD and 429 thousand with diabetes. Air pollution was significantly associated with all-cause mortality for all subgroups. For the full cohort, HRs [95% confidence interval] were 1,06 [1,04-1,07] per 5 µg/m<sup>3</sup> increase in PM<sub>2.5</sub>; 1,05 [1,04-1,06] per 20 µg/m<sup>3</sup> increase in NO<sub>2</sub>; and 1,04 [1,03-1,05] per 1 µg/m<sup>3</sup> increase in EC. Hazard Rates for all-cause mortality were about 2 times higher for people with asthma/COPD compared to the corresponding reference group (e.g. HR PM<sub>2.5</sub>: 1,10 [1,07-1,13] versus 1,04 [1,02-1,06]). Differences in HRs for respiratory mortality were even more pronounced: e.g. HR PM<sub>2.5</sub>: 1,23 [1,16-1,30] versus 1,05 [0,99-1,12]). HRs for people with and without diabetes were more similar to each other. Air pollution was not significantly associated with cardiovascular mortality in any of the subgroups. **Conclusions** We found substantial higher risks for air pollution related mortality for people with asthma or COPD.

## **O02.03.23. Effect Modification of the Association of Long-Term PM2.5 Exposure and Cause-Specific Mortality: An Analysis of 64 Million U.S. Medicare Beneficiaries**

Bingyu Wang

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**Abstract:** Introduction. Long-term exposure to fine particulate matter (PM2.5) has been consistently associated with mortality; however, our understanding of how these associations are modified by certain characteristics, such as urbanicity and race, is more limited. Methods. We considered demographic and mortality data for over 64 million Medicare enrollees across all 40 thousand ZIP codes in the conterminous United States from 2000 to 2008. We linked these data to ZIP code and month-specific PM2.5 exposures estimated using GIS-based spatio-temporal models and fit the data using Cox proportional hazard model that were modified using data aggregation and limited-memory BFGS optimization. This modification allowed our Cox PH model to analyze data simultaneously for all 64 million Medicare beneficiaries within 10 minutes (Intel Xeon E5-2680, 56 cores). We used these models to estimate the association of PM2.5 on all cause, cardiovascular (CVD), respiratory disease and cancers (including specifics: ischemic heart disease, cerebrovascular disease, congestive heart failure, COPD, pneumonia, upper respiratory infection (URI), lung cancer), with strata for age, race, gender, and ZIP code of residence. We examined effect modification by age, race, gender, land use, and region and assessed the linearity of the dose-response relationship for each cause and by modifier. Results. We found significant positive associations of PM2.5 and all causes of death, except URI, with mortality risk ratios (RR) for non-accidental, CVD, respiratory, and cancer mortality equaling 1.244 (95% CI: 1.238, 1.251), 1.683 (95% CI: 1.669, 1.696), 1.241 (95% CI: 1.223, 1.260) and 1.160 (95% CI: 1.147, 1.172) per 10 ug/m<sup>3</sup> increase in PM2.5, respectively. We showed risk of death to be higher for beneficiaries living in urban as compared to non-urban areas, for men as compared to women, for younger ages, and individuals living in the northeastern US. PM2.5 associated RRs were similar for whites and non-whites.

## **O02.03.24. Long-Term Effect of Air Pollution on Mortality in England and Wales 2001-2006: A Change on Change Analysis**

Paul Wilkinson

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**Abstract:** Background/Aim: Long-term exposure to air pollution, particularly fine particles is known to be associated with mortality, suggesting the recent improvement in air quality in the UK might have resulted in positive impacts on mortality. We investigated the association between changes in pollution exposure and changes in mortality by small areal units (Lower level Super Output Areas - LSOAs) with a self-matched design (change on change analysis). Methods: Hour-by-hour concentrations of PM<sub>2.5</sub> (and components), PM<sub>10</sub> and O<sub>3</sub>, 2001-2006 were modelled at 5 km grid resolution using the regional atmospheric chemistry transport model, EMEP-WRF and linked to annual cause-specific mortality, and annual average at LSOA level (n=34,366). Conditional Poisson regression models were applied to estimate the association between changes in pollution and changes in mortality, allowing for mortality trend and overdispersion with adjustment for time-variant annual mean temperature and temporal auto-correlation in the counts of deaths. We also examined modification of the air pollution effect by time-invariant ecological characteristics such as urbanicity and areal socioeconomic status using interaction terms. Results: In total, 3,122,751 all-cause, 1,173,071 cardiovascular disease (CVD) and 422,703 respiratory disease deaths were analysed. A 10µg/m<sup>3</sup> increase in PM<sub>2.5</sub> was associated with 12.1% (95%CI: 10.5, 13.7), 16.0% (13.3, 18.7) and 16.4% (11.7, 21.4) increase in all-cause, CVD and respiratory disease mortality, respectively after adjusting for temperature and allowing for mortality trend. The effects varied among regions. There was significant effect modification by population density suggesting impacts were limited to highly populated areas. Results for PM<sub>10</sub> were broadly similar with smaller effect size. Conclusions: Our current analysis suggested recent reduction in exposure to ambient fine-particulate air pollution contributes to measurable reduction in mortality in England and Wales.

## O02.03E. Global Health Equity Issues Related to Pesticide Use

### **O02.03.25. The Relationship between Urinary Levels of Dialkyl Phosphates and Reproductive and Anthropometric Development of Boys in the Rural Western Cape in South Africa**

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**Abstract:** Background Many agricultural pesticides currently in use are hormonally active but few previous studies have investigated their effect on the reproductive and anthropometric development of pubertal boys. Objective This study investigated the relationship between urinary dialkyl phosphates and reproductive and anthropometric growth of boys from the rural Western Cape in South Africa. Methods A cross-sectional study of 183 school boys residing on farms and neighbouring non-farming areas was conducted. Measurements included a questionnaire, clinical assessment of sexual maturity development (SMD), anthropometric measurements (height, weight and body mass index), serum reproductive hormones (including luteinizing hormone, follicle stimulation hormone, testosterone and oestradiol) and urinary levels of 3 dialkyl phosphates (organophosphate pesticide metabolites) including di-ethyl, di-methyl and di-methyl triphosphate (DEP, DMP and DMTP). Results The median (interquartile range) of age and sum dialkyl phosphates of the school boys was 12 years (9-13 years) and 68.3 ng/mL (27.9-129.5 ng/mL) respectively. There were consistent, mostly non-significant associations, between urinary levels of dialkyl phosphates and adverse effects on outcomes including SMD, reproductive hormones, anthropometric development. There was a strong positive association and dose response found between BMI > 50th percentile and quartiles of DMTP (odd ratio and confidence interval for highest and lowest quartile: 3.3; 1.2 -9). Conclusion the results provide some preliminary evidence that organophosphate pesticides exposure could adversely affect the body size of school boys and weak evidence of other adverse effects on male reproductive development. These findings require further investigation in a larger longitudinal study with seasonal bio-monitoring for pesticides.

## **O02.03.26. Pesticides in the Urine of Preschool Children from Germany and Their Relevance to Human Health**

Martin Kraft

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**Abstract:** The general population is exposed to a wide variety of health relevant pesticides which are most commonly used in agriculture and consumer products. Typically used pesticides in Germany are Organophosphate-Insecticides, Pyrethroids, Neonicotinoids and Glyphosate. With the exception of Glyphosate these substances are quickly metabolized in the human body when incorporated. Human Biomonitoring methods offer the possibility to measure the metabolites or the parent compound (Glyphosate) in the urine of exposed individuals. For some pesticides specific biomarkers are available and can be used for a health based risk assessment on the basis of Acceptable Daily Intakes (ADIs). The aims of our study were to estimate the magnitude of children's exposure to pesticides and to compare the calculated daily intake to established health based risk values. 95 children (2-6 yrs) participated in our human biomonitoring study. Overall, 20 metabolites of Organophosphate-Insecticides (8), Pyrethroids (8), Neonicotinoids (4) and Glyphosate as parent compound were measured in the urine of the children. With an established toxicokinetic model, we calculated the intake of Chlorpyrifos, Deltamethrin and Glyphosate in these children. We measured a broad range of exposure to pesticides in our study population. The highest concentrations could be found for Organophosphate metabolites, followed by the metabolites of Pyrethroids and Neonicotinoids. Comparatively low concentrations in the urine could be detected for Glyphosate. The estimated daily intake of Deltamethrin and Glyphosate was below the ADI. Approximately 5 % of the children showed intake values above the ADI for Chlorpyrifos. In conclusion, children in Germany were found to be exposed to different groups of pesticides. By using specific biomarkers we can show that exposure to Chlorpyrifos may pose a public health concern whereas the exposure to Deltamethrin and Glyphosate is below health relevant thresholds.

### **002.03.27. Prospective Association of DDT and DDE Exposure with High Blood Pressure among Adult Women from Mexico**

Lea Cupul-Uicab

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**Abstract:** Introduction and Objective High levels of DDT and DDE might increase the risk of developing hypertension among adults; epidemiological evidence however, is unclear. We prospectively assessed whether non-occupational exposure to p,p'-DDE and p,p'-DDT were associated with high diastolic and systolic blood pressure among women from Tapachula, Chiapas, a highly exposed area of Mexico. Methods Levels of p,p'-DDE and p,p'-DDT were determined in serum samples drawn when women were recruited (2002-2003), they were clinically healthy with no prior diagnosis of diabetes and hypertensive disorders at that time. We followed women from the Tapachula cohort (2015-2017); systolic (SBP) and diastolic blood pressure (DBP) of the women (n=253) were measured (mmHg) twice. The risk of having high blood pressure (HBP: SBP>120 and DBP>80 mmHg) was modeled with logistic regression. Results Median levels of DDE were 3.02 µg/g of lipids and of DDT were 0.29 µg/g; 22.5% of the women had HBP. Relative to the least exposed (DDE≤3.00 µg/g), the adjusted odds ratio for women with 3.01-6.00 µg/g was 2.25 (95% CI: 1.1, 4.8); for those with 6.01-9.00 was 1.13 (95% CI: 0.4, 3.5); and for those with the highest exposure (>9.00) was 1.17 (95% CI: 0.5, 2.9). Increasing levels of DDT exposure showed a small positive association with HBP before adjusting, which disappeared after taking into account important confounders. Conclusions Our results provide some support of the potential adverse effect of non-occupational exposure to DDT on high blood pressure in adult population. Women from the Tapachula Cohort were initially healthy with no hypertensive disorder when their exposure was determined; they were also exposed to DDT for various decades.

## **002.03.28. Insecticide Exposure and Wheeze in 5-Year Old Children from the Infants' Environmental Health Study (ISA)**

Berna Van Wendel de Joode

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**Abstract:** Background: Organophosphate insecticides may affect children's respiratory health, however, data are scarce. We examined whether prenatal and current chlorpyrifos and pyrethroid insecticide exposures were associated with wheeze in children from the Infants' Environmental Health Study (ISA) in Costa Rica. Methods: We interviewed mothers from 5-year old children (mean  $5.5 \pm 0.4$  years) ( $n=303$ ) about children's wheeze during the last 12 months using the ISAAC questionnaire. We measured pesticide metabolite concentrations in maternal urine collected 1-3 times during pregnancy and in children's urine obtained at 5 years: TCP for chlorpyrifos; DCCA for the pyrethroids permethrin, cypermethrin, and cyfluthrin; and 3PBA for permethrin, cypermethrin, and deltamethrin. For each metabolite, we created 'high' and 'low' exposure groups by calculating the 75th percentile of the averaged concentrations during pregnancy, as well as the current concentrations, adjusting for specific-gravity. We ran multivariable separate logistic regression models for prenatal and current pesticide metabolite concentrations (high/low) and wheeze during the last 12 months, adjusting for maternal smoking during pregnancy, child's sex, and parity. Results: Twenty percent of the children had at least one episode of wheeze during the last twelve months. Seventy-fifth percentile prenatal and current concentrations were, respectively: TCP 2.5 and 2.3  $\mu\text{g/L}$ , DCCA 2.4 and 4.5  $\mu\text{g/L}$ , 3-PBA 1.4 and 3.8  $\mu\text{g/L}$ . Current high DCCA concentrations were associated with an increased risk of wheezing OR=2.1 (95%CI 1.1-3.9), whereas prenatal DCCA were not OR=0.7 (95%CI 0.3-1.4). Current high 3PBA concentrations were marginally associated OR=1.7 (95%CI 0.9-3.3), whereas prenatal concentrations were not OR=1.0 (95%CI: 0.5-2.0). Prenatal or current TCP concentrations were not associated with wheeze. Conclusions: Current exposure to pyrethroid insecticides may increase the risk of wheeze in young children.

## **O02.03.29. Pesticides and Lung Health: Pediatric Association between Agricultural Pesticide Use and Respiratory Health in Fresno, California**

Rachel Severson

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**Abstract:** Previous studies suggest that exposure to pesticides may be linked to increased risk of pediatric asthma; however, there is currently insufficient evidence to demonstrate a causal link. We investigated the association between exposure to agricultural pesticide application of three classes of pesticides (organophosphates (OP), carbamates (C), and methyl bromide (MeBr)) and lung function in a pediatric cohort in Fresno, CA, a community with intense agricultural pesticide use and high asthma prevalence. Study participants were members of the Fresno Asthmatic Children's Environment Study (FACES), a cohort of racially and ethnically diverse children recruited from ages 6 - 11 with a physician diagnosis of asthma. We developed the "purexposure" package in R to pull publically available data from the California's Department of Pesticide Regulation and calculate exposure to pesticide application. Exposure to three classes of pesticides was estimated by calculating the kilograms of relevant pesticides applied within a 3,000-meter buffer around each child's home for the year prior to the baseline measure of FEV1. Study participants' baseline measure of forced expiratory volume in the first second (FEV1) was the primary outcome for this analysis. The association between pesticide application and FEV1 was estimated by fitting a generalized linear model controlling for sex, age, height, and weight. Compared to participants in the lowest quartile of pesticide exposure, participants in the highest quartile of exposure demonstrated a positive association between FEV1 and exposure to OP (RR: 1.004, 95% CI: 1.004, 1.018), C (RR: 1.004, 95% CI: 1.004, 1.017), and MeBr (RR: 1.006, 95% CI: 1.007, 1.020). These results do not support our hypothesized harmful association between FEV1 and exposure to pesticides, and suggest that the association between pesticide application and lung function may be confounded by other environmental exposures such as air pollution.

## 002.03F. Interventions to Reduce Household Air Pollution from Cooking and Biomass Burning

### 002.03.31. Exposures to PM<sub>2.5</sub> Associated with LPG Stove and Fuel Interventions in Four Countries: Pilot Results from the HAPIN Trial

Michael Johnson

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**Abstract:** Background: The Household Air Pollution Intervention Network (HAPIN) Trial is a multi-country effort to demonstrate the effects of a liquefied petroleum gas (LPG) stove and fuel distribution intervention on birthweight, child health, and adult chronic disease. Here we summarize the pilot baseline and post-intervention PM<sub>2.5</sub> exposure measurements from the four field sites, which were conducted to determine the potential of detecting improvements in women and children's health. Methods: 24 and 48-hr personal exposures to PM<sub>2.5</sub> on the primary cook were assessed in Guatemala, India, Peru, and Rwanda. Exclusive use of LPG was strongly encouraged post-intervention to determine the lower end of potential exposures. Specific instrumentation and sampling approaches varied across centers due to logistical considerations during the pilot period, but all used paired before/after designs and gravimetric-based systems. Data in Peru was collected for the Cardiopulmonary Outcomes and Household Air Pollution (CHAP) Trial ([www.ncbi.nlm.nih.gov/pubmed/29100550](http://www.ncbi.nlm.nih.gov/pubmed/29100550)). Results: Mean 24-hr personal exposures were consistently and substantially lower when using LPG compared to biomass for all sites: Guatemala (251 µg/m<sup>3</sup> [n=36] vs 41 µg/m<sup>3</sup> [n=12], 84% reduction); India (125 µg/m<sup>3</sup> [n=40] vs 22 µg/m<sup>3</sup> [n=12], 82% reduction); Peru (119 µg/m<sup>3</sup> [n=49] vs 24 µg/m<sup>3</sup> [n=26], 79% reduction), and Rwanda (210 µg/m<sup>3</sup> [n=35] vs 65 µg/m<sup>3</sup> [n=36], 69% reduction). Conclusions: The range of exposures falls on the steep sections of known exposure-response curves, implying potentially important health benefits with a gas intervention. The exposure reductions are also relatively large compared to those reported for

other household energy interventions, including for some associated with liquid or gas fuels. The results suggest clean fuel interventions may lower exposures to near or below the WHO interim-1 target of 35  $\mu\text{g}/\text{m}^3$ , though efforts to minimize stacking and exposure contributions from other sources remain critical.

### **002.03.32. Initial Household- and Village-Level Impacts of Residential Coal Use Restrictions on Indoor Air Quality in Rural Homes in Beijing, China**

Xiaoying Li

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**Abstract:** China is conducting a large-scale replacement of high-polluting, traditional heating stoves in rural areas with electricity- and natural gas-powered clean heating systems due to the contribution of residential coal combustion to air pollution. We conducted a feasibility study among 300 households in three districts in the Beijing Municipality Region to collect baseline information on heating technologies and usage patterns, housing characteristics, and indoor air pollution. In each district, one treatment village (coal restricted and access to heat pump replacement program) and a similar non-treatment village (not coal-restricted and no access to heat pump replacement program) were selected. We measured 24-h indoor concentrations of fine particulate matter (PM<sub>2.5</sub>, 5-min resolution) in a subset of homes in each village (n = 4-6 homes per village) using a laser photometer (DustTrak 8520, TSI Inc, measurements corrected for known light-scattering bias). Hourly outdoor PM<sub>2.5</sub> concentrations were obtained from the nearest environmental air quality monitoring stations in each district, and used to calculate hourly ratios of indoor-to-outdoor (I/O) PM<sub>2.5</sub>, as a means to initially investigate the influence of outdoor and indoor sources of PM. Our preliminary results suggested that the subsidized clean heating technologies replaced coal in 2 of the 3 treated villages and were associated with lower indoor PM<sub>2.5</sub> concentrations. In the 2 treated villages that stopped using coal, geometric mean (95% CIs) 24-h indoor concentrations of PM<sub>2.5</sub> were non-significantly lower compared with untreated homes in the same district [geometric mean [treated: 162 (85,307) µg/m<sup>3</sup> vs. un-treated: 222 (141,351) µg/m<sup>3</sup>]. We also found that the average hourly I/O PM<sub>2.5</sub> ratios were lower in treated homes compared with untreated homes in the same district [treated: 2.7 (1.4, 5.0) vs. un-treated: 3.9 (2.7, 5.5)], suggesting that indoor sources may contribute less to measured indoor PM<sub>2.5</sub> in these homes.

## **002.03.33. Government Policy, Clean Fuel Access, and Persistent Fuel Stacking in Ecuador**

Carlos Gould

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**Abstract:** **BACKGROUND:** There is now strong evidence that exclusive clean cooking fuel use, eliminating all biomass combustion, is necessary to obtain health benefits from reducing exposure to household air pollution. Ecuadorian households have had access to low-cost liquefied petroleum gas (LPG), financed by large direct government subsidies for more than three decades. Here, we evaluate the development of the LPG subsidy and the extent to which it has resulted in shifts to clean cooking. **METHODS:** We describe the development and impacts of LPG subsidies using a mix of methods: 1) review of academic literature, newspapers, and government records; 2) key informant interviews (n=9); 3) surveys conducted in rural, northern Ecuadorian households (n=383) assessing cooking patterns; and 4) focus groups (n=6) in a subset of surveyed households to better characterize survey findings. **FINDINGS:** LPG subsidies were developed for reasons other than direct health or economic benefits gained from transition to clean cooking fuel from biomass combustion. Nonetheless, these efforts have resulted in 90% of Ecuadorian households cooking primarily with LPG. Among the rural households surveyed, LPG use and satisfaction was high, however, more than three-quarters of those surveyed reported weekly woodfuel use. Focus group discussions revealed that LPG accessibility and inconsistent delivery was a persistent barrier to exclusive use among study households. **CONCLUSIONS:** Ecuador provides valuable lessons that can guide current and future national clean fuel programs. This study represents one of the first efforts to describe long-term cooking practices in the presence of low-cost LPG. This study highlights that nationally-representative surveys that measure only "primary cooking fuel" may underestimate solid fuel use as a supplemental household energy, particularly in areas where limited fuel availability plays a stronger role.

### **O02.03.34. Exploring Barriers and Practical Solutions for the Uptake and Use of Clean Cooking through Photovoice Methods: The LPG Adoption in Cameroon Evaluation (LACE) Studies**

Daniel Pope

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**Abstract:** Background: Each year up to 4 million people die prematurely from household air pollution due to domestic use of solid fuel, mainly in low and middle-income countries (LMICs). Liquefied Petroleum Gas (LPG) is an affordable, scalable, and widely available clean fuel that provides health and environmental benefits when used for household energy in LMICs. In Cameroon, where 70% of people rely on biomass for cooking, the Government aims to increase LPG use from < 20% to 58% by 2035. Few qualitative studies have explored households' perceptions of factors affecting LPG uptake. We conducted community-based participatory research using photovoice methods to explore factors influencing LPG uptake and sustained use in South-West Cameroon. Methods: Two groups of participants from rural (n=7) and peri-urban (n=8) areas photographed aspects of their lives which prevented/enabled LPG uptake in their communities. Individual interviews (n=15) and group discussions (n=5) explored participants' reflections on the issues photographed. We conducted thematic analysis using NVivo 10 software. Results: Main barriers included difficulty in affording the initial LPG equipment and ongoing refills, scarcity of LPG retail shops and safety concerns. Key enablers/solutions included (i) increasing awareness of the benefits of LPG, (ii) additional retail shops, (iii) addressing safety concerns, (iv) repairing roads to improve distribution, and (v) reducing the refill price. We organised an exhibition of participants' photos to generate discussions between participants and representatives from government, communities, industry and media about how to assist communities with fuel transition. Conclusions: Photovoice was found to be an effective participatory approach that (i) identified factors affecting uptake and use of LPG, which could be transferable to Sub-Saharan contexts, and (ii) engaged with participants and key stakeholders to identify how to advance equitable access to LPG in Cameroon.

## **002.03.35. Effectiveness of Liquefied Petroleum Gas Stove Ownership for Reducing Household Air Pollution Exposure during Pregnancy in Guatemala**

Laura Grajeda

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**Abstract:** Background: Household air pollution from solid fuel use has been associated with adverse birth outcomes. Efforts to reduce exposure focused on chimney stoves have had limited success, and switching to liquefied petroleum gas (LPG) fuel is a promising alternative. Moreover, estimating a person's typical exposure has been a challenge in epidemiological studies, due to temporal variability. Objectives: We aimed to estimate the effectiveness of LPG stove ownership for reducing personal exposure to fine particulate matter (PM<sub>2.5</sub>) and describe the between- and within-person variation in exposure during pregnancy. Methods: We recruited women at <20 weeks of gestation in highland Guatemala and measured 24-hour average personal PM<sub>2.5</sub> exposure three times using an impactor with a Teflon filter and a pump. We used linear mixed effects model to estimate the variance components of log PM<sub>2.5</sub>, subject-specific typical personal exposures and the exposure reduction associated with stove ownership. Results: We obtained 559 repeated measurements from 218 pregnant women. Among them, 59 (27%) owned a LPG stove and 379 (68%) owned a chimney stove at recruitment. Typical exposure was 57 µg/m<sup>3</sup> (95%CI: 49-66) and 96 µg/m<sup>3</sup> (95%CI: 87-106) for women with and without an LPG stove, respectively. After adjusting for confounders, LPG stove ownership was associated with 41% lower personal PM<sub>2.5</sub> (95%CI: 27 to 52). Intraclass correlation coefficients was 0.51 (95%CI: 0.42-0.59) overall, and for women with and without LPG stove were 0.46 (95%CI: 0.27-0.62) and 0.46 (95%CI: 0.36-0.56), respectively. Conclusions: Effectiveness of LPG stoves for personal exposure reduction in pregnant women was moderate and might depend largely on the extent of adoption. The relatively high correlation among repeated exposure measures within individuals in this setting suggests that a small number measures per individual can provide a reliable estimation of typical exposure during pregnancy.

### **O02.03.36. Indoor Nitrogen Dioxide in Homes with Biomass Cookstoves before and after a Gas Stove Intervention**

Josiah Kephart

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**Abstract:** Emissions from biomass-fueled cookstoves are the largest environmental contribution to the global burden of disease, responsible for 2.6 million deaths annually. A transition from biomass to liquified-petroleum gas (LPG) cookstoves has been proposed as a global public health intervention. While this transition seems likely to reduce fine particulate matter and carbon monoxide, very little is known about cookstove-related emissions of nitrogen dioxide (NO<sub>2</sub>), a threat to respiratory health. Assessing exposure to NO<sub>2</sub> from biomass and LPG cookstoves is essential to understand the public health risks posed by biomass cookstoves and inform the current promotion of LPG as a healthier alternative to biomass fuel. This study aims to 1) quantify NO<sub>2</sub> exposure from biomass cookstoves and 2) assess changes in NO<sub>2</sub> exposure after the transition from biomass to LPG cookstoves. We will measure NO<sub>2</sub> concentrations in 100 kitchens with biomass cookstoves in rural Puno, Peru. Concentrations will be sampled by direct-reading instruments at one-minute intervals for 48 hours, allowing us to quantify both daily mean concentrations and short-term concentration peaks associated with cooking events. To assess the effect of transitioning from biomass to LPG on kitchen NO<sub>2</sub> concentrations, we will randomize 50 of these households to receive free LPG stoves and fuel and 50 households to serve as a control. We will measure NO<sub>2</sub> concentrations three months post-intervention. In our study setting, homes with biomass cookstoves experienced daily NO<sub>2</sub> concentrations [48-hour mean (sd): 139 ppb (92), n=99] well above the WHO indoor annual guideline (21 ppb). Acute exposures were also elevated, as 26% of kitchen-hours [1-hour mean (sd): 139 ppb (252), n=2376 hours] were above the WHO indoor hourly guideline (105 ppb). Transitioning from biomass to LPG cookstoves reduced daily NO<sub>2</sub> concentrations by 40%, however these concentrations [mean (sd): 73 ppb (47), n=40] remain above the WHO annual guideline (21 ppb).

## 002.03G. Noise Effects 1

### **002.03.37. Effect Modification of the Association of Long-Term PM2.5 Exposure and Cause-Specific Mortality: An Analysis of 64 Million U.S. Medicare Beneficiaries**

Daniel Nguyen

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**Abstract:** Background: Aircraft noise is a key concern for communities surrounding airports, with increasing evidence for cardiovascular health effects. While changes in technology have resulted in quieter aircraft, aviation demand in the U.S. has increased over time with varying patterns by airport and U.S. region. As part of the first longitudinal national-scale compilation of civil aviation noise exposure estimates, we aim to evaluate trends in aviation noise exposure over time in the U.S. Methods: Noise contours were modeled for 90 U.S. airports in 5-year intervals between 1995 and 2015 using the Aviation Environmental Design Tool. We utilized linear fixed effects models to estimate changes in the sizes of exposure areas by U.S. Census regions/divisions with  $\geq 65$  dB or  $\geq 55$  dB day-night average sound level (DNL) corresponding to the current FAA regulatory threshold and a 10 dB lower level for comparison, respectively. We overlaid noise contours and Census block data from the U.S. Census Bureau and American Community Surveys for 2000 to 2015 in a geographic information system to estimate population changes within noise levels. Results: National-scale analyses showed non-monotonic trends in mean exposed areas for  $\geq 65$  and  $\geq 55$  dB DNL over time that peaked in 2000; exposed areas were the largest in the Midwest region from 2000 to 2005. While exposed areas across most regions declined after 2000, only the West region increased from 2010 to 2015. There were notable declines in exposed populations over time; for example exposure in New England decreased by 89% and 56% in total population living within the  $\geq 65$  and  $\geq 55$  dB areas, respectively, from 2000 to 2010. Conclusions: Our analyses reinforce the complex patterns of aircraft noise exposure over time and space across the U.S., with trends affected by the economy/enplanement, airport operations, runway additions, and technology evolution. These data will provide the foundation for cohort studies on aircraft noise and health in the U.S.

## **002.03.38. Exposure to Road Traffic Noise and Cognitive Development in Primary Schoolchildren**

Maria Foraster

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**Abstract:** Exposure to aircraft noise may lead to impaired cognitive performance in schoolchildren, but the evidence for road traffic noise is still limited. We studied the association between long-term exposure to road traffic noise and schoolchildren's cognitive development. We followed-up a population-based sample of 2715 children aged 7-10 years from 39 socioeconomically paired schools in Barcelona (Catalonia, Spain). Children underwent computerized cognitive tests 4 times during one year to assess growth (n = 10112). We assessed working memory (2-back task, detectability), superior working memory (3-back task, detectability), and inattentiveness (Attention Network Task, hit reaction time standard error). Traffic-related noise and air pollution were measured indoors and outdoors at schools, at the start of the school year and 9 months later. Noise was measured with a type II sound level meter using standard protocols to obtain long-term A-weighted average levels (LAeq, in dB). We obtained indoor noise levels in all classrooms by correcting for classroom orientation and change between years. Linear mixed effects models were adjusted for age, sex, maternal education, socioeconomic status, and traffic-related air pollution. Exposure to road traffic noise outdoors at schools was consistently associated with smaller working memory (2-back and 3-back) and greater inattentiveness growth in children. E.g., an interquartile range increase in noise was related to -7.51 points (95%CI: -11.1; -3.91) in 3-back detectability. Exposure to road traffic noise in classrooms was only associated with inattentiveness. Associations were robust to all adjustment sets. Children exposed to greater outdoor levels of road traffic noise at schools exhibited slower cognitive development. Exposure to road traffic noise in classrooms, where noise levels are lower, was associated only with inattentiveness, which might suggest that inattentiveness is a more noise sensitive outcome than working memory.

## **002.03.39. Road Traffic Noise, Air Pollution, and Risk of Dementia: Results from the Betula Project**

John Andersson

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**Abstract:** **BACKGROUND:** There is growing evidence for a negative impact of traffic-related air pollution on risk of dementia. But traffic also generates noise, and to our knowledge, the contribution of noise exposure to this association has not been previously examined. **OBJECTIVE:** The aim of this study was to investigate the individual and combined effect of noise and air pollution on risk of dementia. **METHODS:** Data on dementia incidence over a 15 year period was obtained from the Betula project, a longitudinal study on health and ageing. Estimates of annual mean levels of nitrogen oxides (NOx) at the participants' residential address were obtained using a land-use regression model. Modelled data provided road traffic noise levels (Leq 24h) at the participants' residential address at baseline. Cox proportional hazard regression was used to calculate hazard ratios (HR). **RESULTS:** Of 1721 participants at baseline, 302 developed dementia during the follow up period. Exposure to noise levels (Leq 24h) >55dB had no significant effect on dementia risk (HR 0.95; CI: 0.57, 1.57). Residing in the two highest quartiles of NOx exposure was associated with an increased risk of dementia. The risk associated with NOx was not modified by adjusting for noise. Nor did we find any significant interaction effects between NOx and road traffic noise on dementia risk. **CONCLUSION:** We found no evidence that exposure to road traffic noise, either independently or in combination with traffic air pollution, was associated with risk of dementia in our study area. Our results suggest that pollution should be considered the main component in the association between traffic related exposures and dementia. We believe that these result contribute to the growing understanding of the associations between traffic pollution and dementia, which in turn could prove valuable for planning and building sustainable urban environments.

## **O02.03.40. Modeled and Perceived RF-EMF, Noise and Air Pollution and Symptoms in a Population Cohort: Is Perception Key in Predicting Symptoms?**

Marije Reedijk

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**Abstract:** Introduction Psychosocial research has shown that perceived exposure can influence symptom reporting, regardless of actual exposure. The impact of this phenomenon on the interpretation of results from epidemiological research of environmental determinants on self-reported health is unclear. Methods In this study we compared associations between modeled exposures, the perceived degree of being exposed to these exposures and reported symptoms (non-specific symptoms, sleep disturbances, respiratory symptoms) for three environmental exposures (radiofrequency electromagnetic fields (RF-EMF), noise, and air pollution) which vary in the degree to which they can be sensorially observed. Participant characteristics, perceived exposures, and self-reported health were assessed with baseline (n=14829, 2011/2012) and follow-up (n=7905, 2015) questionnaires in the Dutch population-based Occupational and Environmental Health Cohort study (AMIGO). Environmental exposures were estimated at the home address using spatial models. Cross-sectional and longitudinal regression models were used to examine the associations between modeled and perceived exposures, and reported symptoms. Results The extent to which exposure sources could be observed likely influenced correlations between modeled and perceived exposure as correlations were moderate for air pollution (rSp=0.34) and noise (rSp=0.40), but less so for RF-EMF (rSp=0.11). Perceived exposures were consistently associated with increased symptom reporting (non-specific, sleep, respiratory). In general, modeled exposures were associated with increased symptom reporting, but these associations were strongly attenuated when perceived exposure was accounted for in the analyses. Discussion Perceived exposure has an important role in symptom reporting. Evaluations of environmental determinants of symptom reporting may result in biased estimates if exposure perception is not taken into account.

### **O02.03.41. Modelled and Perceived Noise Exposure and Psychotropic Medication Use**

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**Abstract:** Background Road-traffic noise can induce stress which may eventually lead to mental health disorders. Mental health problems of noise have not are scant in research. People perceive noise differently, this may affect the extent to which noise contributes to poor mental health at individual level. This paper aimed to assess relationships between perceived or modelled noise and use of psychotropic medication. **Methods** We conducted a survey to evaluate perceived exposures of residents of the Helsinki Capital Region of Finland to road-traffic noise and the associations of these exposures with sleep disorder, anxiety and depression. Respondents were randomly sampled from the Finnish Population registry and data was collected using a self-administered questionnaire. Associations between subjective (annoyance) or modelled façade-noise levels and mental health outcome indicators were assessed using generalised additive models while controlling for socioeconomic, lifestyle and exposure-related factors. **Results** A total of 7321 respondents returned completed questionnaires. The proportion of respondents with self-rated moderate to severe road-traffic noise exposure showed a linear trend with higher categories of modelled noise. About 15%, 7% and 7% of respondents used sedative, anxiolytic and antidepressant medicaments, respectively, in the year prior to the study. Perceived noise exposure was clearly associated with anxiolytic drug use only, OR=1.41 (95% CI: 1.02 - 1.95). There was suggestive association between modelled noise and anxiolytic or antidepressant use. In respondents without a quiet façade, modelled noise was more definitively associated with antidepressant use. Noise sensitivity did not modify the effect of noise but was independently associated with increased use of all medication. **Conclusion** We observed few associations between noise and psychotropic medication use. Noise sensitivity was found to predict psychotropic medication use independently of noise.

## **O02.03.42. Long-Term Exposure to Community Noise in Relation to Alzheimer's Disease and Related Dementias**

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**Abstract:** Background: Accruing evidence suggests that a relation of noise exposure to dementia is biologically plausible. Yet the association of long-term exposure to community noise with dementia has not been well-studied. Methods: The Chicago Health and Aging Project, a longitudinal cohort study of adults >65 years, assessed participants' cognitive function and collected other data in triennial home interviews (1993-2011). Using a recently validated method, we predicted the likelihood of dementia or mild cognitive impairment (MCI) for each participant at each interview. We also predicted noise at participant addresses in the 5 years preceding each interview using a land use regression model developed with Chicago-based measurements. We used repeated measures logistic regression models to estimate associations of noise with prevalent dementia and prevalent dementia or MCI, adjusting for age, sex, race, smoking, alcohol, physical activity, income, education, neighborhood socioeconomic status, calendar time, and NO<sub>x</sub>. NO<sub>x</sub>, a traffic-related air pollutant, and a potential source of confounding, was estimated using a spatiotemporal model. Our primary models defined dementia as a dementia likelihood >0.5 standard deviations below the mean; we tested other cutoffs in sensitivity analyses. Results: 5,952 participants underwent a total of 13,551 cognitive assessments. In our primary analyses, 12% of participant exams were classified as having evidence of dementia; 44% had evidence of dementia or MCI. From adjusted analyses, we found that an interquartile range difference in noise (2.7 dB) was associated with a 4% (95% CI: 0.98-1.09) higher odds of prevalent dementia and a 5% (95% CI: 1.01-1.10) higher odds of prevalent dementia or MCI. Less stringent cutoffs strengthened the magnitude of the associations with dementia; associations with dementia or MCI remained unchanged. Conclusion: Long-term noise exposure may contribute to mild cognitive impairment and dementia in older adults.

## 002.03H. Phthalate Exposure and Children's Health

### **002.03.43. Exposure to Endocrine Disrupting Chemicals and Maladaptive Behavior during Adolescence**

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**Abstract:** Introduction: Experimental and epidemiologic studies suggest that exposure to endocrine disrupting chemicals (EDCs), including phthalates and phenols, may influence childhood behavior, but the relationship during adolescence has not been studied. Methods: We investigated the association of EDC exposures with maladaptive behavior in 205 adolescent (age 15 yrs) participants in the New Bedford Cohort, a birth cohort study of chemical exposure and neurodevelopment among residents near the New Bedford Harbor Superfund site, Massachusetts. Urine concentrations of biomarkers of phthalates, phenols and related replacement chemicals were quantified with mass spectrometry. Behavior was assessed with the Behavior Assessment System for Children, 2nd edition Teacher Rating Scale, including the Developmental Social Disorders (DSD) scale related to autistic behaviors. Associations were examined using linear (normally distributed outcomes) or negative binomial (over dispersed Poisson distributed outcomes) regression adjusted for multiple potential confounders. Results: 40% of the adolescents were non-white or Hispanic; at birth, 32% were in low income households and 42% had unmarried mothers. Increased urine concentrations of the molar sum of antiandrogen phthalate biomarkers were associated with an increase in Externalizing Behavior, Behavioral Symptoms Index, and DSD and a decrease in Adaptive Skills. E.g., a doubling of urine antiandrogen phthalate biomarkers was associated with increased Externalizing (RR=1.04; 95% CI: 1.01, 1.08) and DSD ( $\beta=1.4$ ; 95% CI: 0.4, 2.5) behaviors. Associations were stronger in males, but not significantly so. Phenols, other phthalates, and replacement chemicals were not associated with adverse behavior. Conclusion: Our findings support that antiandrogen phthalate exposure during adolescence is a potential correlate of maladaptive behavior.

## **002.03.44. Prenatal and Childhood Phthalate Exposure and Pubertal Development: A 15-Year Birth Cohort Follow-Up Study**

Julie Wang

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**Abstract:** Background: Phthalates are present in many everyday products such as food containers and personal care items, and medical instruments. Prenatal exposure to phthalates may lead to disruption of pubertal development in girls and boys. We aimed to investigate the effect of early life exposure to phthalate esters on pubertal development. Methods: This study included a birth cohort of 437 women and their children between November 2000 to December 2001, there were 143 children followed at 2, 6, 8, 11, and 14 years after birth (2003, 2006, 2009, 2012, and 2016). These women were known to have been exposed to phthalates during pregnancy, and were identified through urine screening during the third trimester. The follow-up examinations for their children included anthropomorphic measurements and evaluation of gender-specific secondary sexual characteristics. A generalized estimating equation model (GEEM) and general linear mixed model (GLMM) analysis were applied. Results: Among the girls, pubic hair development at follow-up was positively associated with maternal urinary concentrations of monoethyl phthalate (MEP) and mono (2-ethyl-5-hydroxyl) phthalate (MEHHP), and total mono (2-ethyl-5-oxohexyl) phthalate (MEHP) at the 5-, 8-, and 11- years stage ( $p < 0.05$  for all). Cervix length, ovary size, Tanner stage, and menarche were all inversely associated with levels of mono-benzyl phthalate (MBzP). Boys' armpit hair development and puberty-related voice changes were positively associated with MBzP; development of pubic hair was positively associated with the maternal total MEHP level. Conclusions: This first through pubertal multiple assessments of 15-year pre-birth cohort follow-up study showed early life exposure to phthalates had positive association with secondary sexual characteristics in general and negative association with sexual organ growth in general.

## **002.03.45. Associations of Maternal Pregnancy Urine Estrogen Levels with Phthalate and Phthalate Replacement (1,2-Cyclohexane Dicarboxylic Acid Diisononyl Ester, DiNCH) Metabolites**

Diana Pacyga

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**Abstract:** Rationale: Pregnant women are exposed to phthalates in food, personal care and household products. Phthalates alter estrogen levels in experimental models but their potential to impact levels in human pregnancy is not well characterized. Methods: 291 participants in an Illinois pregnancy cohort collected 5 urines across pregnancy for pooling and quantification of 16 phthalate/DiNCH metabolites. Exposures were expressed as the molar sum of metabolites for:  $\Sigma$ DiNCH,  $\Sigma$ DEHP,  $\Sigma$ DBP,  $\Sigma$ DiBP,  $\Sigma$ DiNP,  $\Sigma$ PCP, and  $\Sigma$ AA (respective personal care product and anti-androgenic phthalates). At 10-14, 28-30 and 34-36 gestational weeks (GW), urine estradiol, estrone, estriol and metabolites were measured and summed ( $\Sigma$ E). Specific gravity adjusted exposure and  $\Sigma$ E data were log-transformed. Linear mixed-effects models assessed relationships of phthalates/ $\Sigma$ DiNCH with  $\Sigma$ E controlling for fetal sex, maternal age, pre-pregnancy BMI,  $\Sigma$ E analytic batch, and GA at urine collection for  $\Sigma$ E evaluation. Interactions of phthalates/ $\Sigma$ DiNCH, fetal sex,  $\Sigma$ E batch, and GA at  $\Sigma$ E urine collection were explored. Results: Participants were 82% white, 72% had income >\$60,000/yr, 84% had a college+ education, and urine biomarker levels were similar to U.S. women. At 10-14 weeks,  $\Sigma$ E increased with increasing:  $\Sigma$ DBP (b=1.5, 95% CI=0.5, 2.5),  $\Sigma$ DiNP (b=1.3, 95% CI=0.6, 2.0),  $\Sigma$ PCP (b=0.5, 95% CI=0.1, 0.8), and  $\Sigma$ AA (b=0.4, 95% CI=0.01, 0.7); associations in late pregnancy were attenuated and non-significant.  $\Sigma$ E increased with increasing  $\Sigma$ DEHP in women carrying females (b=0.7, 95% CI=0.2, 1.3) and  $\Sigma$ DiBP in women carrying males for  $\Sigma$ E measured in only one analytic batch.  $\Sigma$ E was not associated with  $\Sigma$ DiNCH. Conclusions:  $\Sigma$ DBP,  $\Sigma$ DiNP,  $\Sigma$ PCP, and  $\Sigma$ AA phthalates were associated with higher gestational  $\Sigma$ E in early but not later pregnancy. For other phthalates, associations were only in small sub-group analyses. Whether pregnancy estrogen levels mediate associations between phthalates and pregnancy outcomes merits investigation.

## **O02.03.46. Mixed Phthalate Ester and Phosphate Flame Retardant Exposure and Asthma and Allergies in School Children**

Atsuko Araki

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**Abstract:** Background: Phthalate esters (PEs) and phosphate flame retardants (PFRs) are widely used in interior materials and consumer products. We have reported individual associations between PE and PFR metabolites in urine and children's asthma and allergies, but mixed PEs and PFRs have not yet been studied. Thus, we aimed to find the association between mixed PEs and PFRs and asthma and allergies. Methods: Elementary school children participated in this study. Six PE metabolites were measured using gas chromatography-mass spectrometry (MS); 13 PFR metabolites were measured using liquid chromatography-tandem MS. Wheezing, rhino-conjunctivitis (RC), and eczema were evaluated using International Study of Asthma and Allergies in Childhood questionnaires. Associations between PE and PFR mixtures, and asthma and allergy risk were studied using weighted quantile sum (WQS) regression models adjusted for sex, grade, dampness index, annual house income, parent allergy history, and urine creatinine. Estimated weights of PEs and PFRs as WQS indexes were obtained. The sums of  $\geq 2$  metabolites were calculated as parent compound exposure. Results: Wheezing, RC, eczema, and allergies were prevalent in 29, 46, 36, and 72 of 128 children, respectively. The highest correlations were shown with 5-OH-EHDPHP and  $\Sigma$ TPhP (Spearman's  $\rho=0.525$ ,  $p<0.001$ ), and 5-OH-EHDPHP and  $\Sigma$ TCIPP ( $\rho=0.451$ ,  $p<0.001$ ). WQS index quartile increases showed higher odds ratios (ORs) of RC (OR=2.83; 95% confidence interval=1.28-6.64), eczema (2.71; 1.19-6.58), and any such allergies (6.25; 2.22-20.68). Top three heavily weighted chemicals were as follows: RC, BDCIPP ( $w=0.306$ ),  $\Sigma$ TCIPP (0.311),  $\Sigma$ TBOEP (0.203); eczema, 5-HO-EHDPHP (0.287),  $\Sigma$ TBOEP (0.251), BDCIPP (0.168); and any allergies, BDCIPP (0.383),  $\Sigma$ TBOEP (0.207),  $\Sigma$ TCIPP (0.156). Conclusion: We found positive associations between mixed PE and PFR exposure and allergies risk. TCIPP, TBOEP, EHDPHP, and TDCIPP are the main chemicals that affect allergic symptoms in children.

## **O02.03.47. Prenatal Exposure to Phthalates and Sex Hormone Levels among Adolescent Boys in the CHAMACOS Birth Cohort Study**

Lesliam Quiros-Alcala

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**Abstract:** Background: Phthalates are synthetic compounds widely used in consumer products, including plastics, building materials, and personal care products. Emerging evidence indicates that exposure to these endocrine disrupting compounds could alter reproductive hormones; however, human studies examining in utero exposures are sparse. We examined the associations of prenatal phthalate exposure and reproductive hormones among Latino adolescent boys participating in the longitudinal CHAMACOS birth cohort. Methods: We measured concentrations of 11 phthalate metabolites in maternal prenatal urine. Concentrations of luteinizing hormone (LH), follicle stimulating hormone (FSH), and testosterone were measured in fasting blood samples collected from 110 boys at age 12. Linear regression models examined associations between phthalate metabolites and reproductive hormones, adjusting for income, maternal education, prenatal BMI, and child's age at the 12-year visit. Results: The geometric mean (GSD) of the boys' hormone levels was 2.5 mIU/mL (1.7) for FSH, 1.7 mIU/mL (3.3) for LH, and 66.6 ng/dL (4.2) for testosterone. A two-fold increase in MCBzP and MCPPE concentrations was associated with a respective 15.8% (95%CI: 0.6, 33.3) and 19.8% (95%CI:0.1, 43.4) increase in LH and a 27.3% (95%CI: 5.0, 54.3) and 42.7% (95%CI: 17.0, 74.1) increase in testosterone. A two-fold increase in MCNP, MCOP, MEHP, MECPE, and MEOHP was associated with 28.8% (95%CI:0.2, 65.5), 28.7% (95%CI:4.8, 58.1), 21.3% (95%CI:1.7, 44.7), 25.3% (95%CI:1.8, 54.2), and 22.1% (95%CI:0.8, 47.9) increases in testosterone. Conclusion: Prenatal exposure to phthalates, particularly high molecular weight phthalates, is related to higher levels of reproductive hormones in 12-year old boys, suggestive of earlier onset of puberty.

## 002.03.48. Early Life Exposure to Phthalates in CHILd: A Multi-City Canadian Birth Cohort

Garthika Navaranjan

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**Abstract:** Phthalates, used as plasticizers and solvents, are ubiquitous in the environment. Phthalate exposure has been associated with adverse health effects including childhood asthma and allergic disease. Few studies have examined exposure to phthalates during early life particularly in infancy, a critical window for development. The Canadian Healthy Infant Longitudinal Development (CHILd) Study, a population-based birth cohort, has examined multiple environmental exposures during early life. The goal of this study was to characterize exposure to phthalates during infancy and early childhood in representative participants in the CHILd Study. Pregnant mothers were enrolled 2009-2012 across 4 cities and 1 rural area in Canada. Urine samples were collected at 3, 12 and 36 months of age and, in the first 1,578 children, analyzed for eight phthalate metabolites. Questionnaires were administered at each time point documenting the home environment and maternal and infant behaviours. Geometric mean (GM) metabolite concentrations were calculated at each age. Trends with age and factors that may influence urinary phthalate concentrations were examined using mixed models. Variability between all three measurements were assessed using intraclass correlation coefficients (ICC). Results indicated widespread exposure to phthalates. The highest urinary concentration was for the metabolite MBP at all time points (GM: 15-32 ng/mL). Concentrations of all phthalate metabolites significantly increased with age from 3 to 36 months. Low ICCs were observed for all metabolites (0 to 0.2), suggesting a high degree of variability between measurements from the same child at different ages. There were differences in urinary concentrations of MEP, MBP, MBzP, MCPP depending on study site and urinary MBzP concentrations decreased with mother's age. These data, which will be explored in detail in this presentation, describe widespread exposure to phthalates across a representative sample of the CHILd Study.

## 002.03I. Source-Specific Air Pollution Exposures and Health

### 002.03.49. Improved Air Quality Saved Lives: A Mediation on Particulate Matters

Ana Rappold

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**Abstract:** Background: In the United States, cardiovascular mortality rates have declined along with improvements in air quality. Between 1990 and 2010, cardiovascular mortality decreased by 45.66% (standard error SE=0.02%) while fine particulate matter (PM<sub>2.5</sub>) exposures decreased by 29.5% (SE=0.2%). We investigate the extent to which reductions in cardiovascular mortality rates can be attributed to reductions in PM<sub>2.5</sub>. Methods: We obtained cardiovascular standardized mortality rates (SMR) for 2132 counties from the US National Center for Health Statistics between 1990 and 2010. We use the Community Multiscale Air Quality model to calculate population-weighted annual average PM<sub>2.5</sub> concentrations for each county. We adapt mediation analysis to calculate the PM-related cardiovascular mortality rates. We examine which PM components and their emission sources contribute most to PM<sub>2.5</sub>-related mortality. Results: Between 1990 and 2010, cardiovascular SMR related to total PM<sub>2.5</sub> decreased by 12.3 (SE=0.4) deaths per 100,000 person-years, approximately 6.5% (SE=0.2%) of the overall decrease in cardiovascular SMR. Reduction in particulate sulfate levels, driven by reductions in sulfur dioxide emissions, mediated 10.8 (SE=0.6) cardiovascular SMR. Per unit mass of emissions, reduction in elemental carbon is most efficient at 1.20 (SE=0.10) cardiovascular SMR per metric kiloton. Emissions of elemental carbon from mobile vehicles have significantly decreased, while emissions from wildland fires and other area sources have increased. Conclusions: Particulate sulfates contribute the most to total PM<sub>2.5</sub>-related cardiovascular mortality, but reductions in carbon was more efficient at reducing PM<sub>2.5</sub>-related cardiovascular mortality. The statements in this abstract do not necessarily reflect the views of the EPA.

## **002.03.50. Health Risk of Living near a Coal Electric Power Plant: A Residential Cohort Study in North-Western Italy**

Fabrizio Minichilli

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**Abstract:** In North-Western Italy, an Electric Power Plant (EPP) has been active since the early 1970s. In 2014, two production sections fed by coal were seized by the Prosecutor's Office, while a section powered by natural gas is still functioning. To evaluate the association between exposures of residents in an area affected by EPP's emissions and the risk of hospitalization and mortality a population-based cohort study was conducted (follow-up 2001-2013, 1,418,000 person-years). Lympho-hematopoietic and lung cancers, nervous system, cardiovascular and respiratory diseases were analysed. The diffusion of SO<sub>2</sub> and NO<sub>x</sub> was estimated for the main sources of pollution (EPP, other industries, roads, port areas and urban heating) using the MOLOCH-ABLE-ADMS model. Modelled concentrations of SO<sub>2</sub> were used as proxy of residential exposure to air pollution of EPP (SO<sub>2</sub>-EPP); NO<sub>x</sub> was used as proxy of Multi-Source Model including all sources of pollution (NO<sub>x</sub>-MSM). For males (M) and females (F) Hazard Rate Ratios (HRR) adjusted by age, socio-economic deprivation and NO<sub>x</sub>-MSM were computed according to quartiles of SO<sub>2</sub>-EPP concentrations. Linear Trend of HRR was performed (THRR). Mortality analysis showed increased risk for all cancers [THRR-M 1.15 95%CI (1.11-1.19); THRR-F 1.10 95%CI (1.11-1.19)], lympho-hematopoietic cancers [M 1.30 (1.14-1.48); F 1.17 (1.01-1.35)], nervous system [M 1.10 (1.00-1.22); F 1.12 (1.02-1.22)], cardiovascular [M 1.11 (1.07-1.16); F 1.16 (1.12-1.20)], and respiratory diseases [M 1.23 (1.13-1.33); F 1.17 (1.07-1.27)]. Results of hospitalization analysis were largely consistent with those of mortality analysis. The risk excesses associated to exposures attributed to the coal plant have been obtained for mortality or hospitalization causes for which the evidence of association with atmospheric emissions is persuasive. The results reinforce the knowledge on the dangers of the use of coal for energy production and the consequent indication to decarbonise to protect health.

### **O02.03.51. Preterm Birth among Infants Exposed to in Utero Ultrafine Particle Emissions from Aircraft Engines near the Los Angeles International Airport**

Sam Wing

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**Abstract:** Ambient air pollution is a known risk factor for adverse birth outcomes, but the role of ultrafine particles (UFPs) is not yet well understood. UFP emissions from aircraft are spread across large residential areas downwind of airports, possibly causing a considerable reproductive health burden. Birth certificate data from the California Department of Public Health was drawn from all births by mothers living in a 200 mi<sup>2</sup> area downwind of Los Angeles International Airport (LAX) in 2011 (n=16,268). These records were used to ascertain the presence preterm birth (PTB), as well as maternal covariate information. To assess in utero exposure to UFPs, we input geocoded maternal addresses into a novel geospatial UFP dispersion model that has been validated by extensive ground-level measurements near LAX. We used multiple logistic regression, regressing PTB (live birth < 37 weeks gestation) on UFP concentrations estimated from the dispersion model. We adjusted for maternal factors like age, educational attainment, and race/ethnicity. We further adjusted for measures of air pollution from other sources, like traffic, including PM<sub>2.5</sub>, nitrogen oxides, and surface ozone to isolate the role of aircraft-related UFPs. An interaction term between UFPs and maternal nativity was included in the model. Among this birth cohort, we found an 11% increase in odds (95% CI: 1.01, 1.22) of PTB per interquartile range of UFP exposure. When stratified by maternal nativity, no increase in PTB among infants of foreign-born mothers was detected (OR = 1.02, 95% CI: 0.90, 1.16) but was detected among infants of US-born women (OR = 1.19, 95% CI: 1.06, 1.32). Effect modification by nativity was borderline statistically significant (p = 0.04). We found increased exposure to aircraft-related UFPs was associated with an elevated risk of PTB, serving as evidence of the reproductive health effects of UFP exposures from aircraft emissions. However, this relationship appears to be modified by maternal nativity.

## **002.03.52. Integrative Strategy for Finding Co-Location Patterns between Adverse Birth Outcomes and Industrial Air Pollution**

Charlene Nielsen

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**Abstract:** The relationship of many hazardous pollutants present in ambient air with adverse birth outcomes (ABO) is still unknown, particularly from those released by industry. The knowledge gap is even greater when considering the impact of mixtures of hazardous pollutants on pregnancy outcomes. We aimed to collaboratively overcome methodological limitations to identify potential hazardous mixtures of industrial air pollutants spatially related to the occurrence of ABO in Alberta. We applied integrative data analyses on large existing databases (2006-2012) from (i) the National Pollutant Release Inventory on chemicals released into air by industry; (ii) the Alberta Perinatal Health Program on births, known maternal risk factors for ABO, and the maternal postal code at birth; (iii) an area-level socioeconomic status index (SES). We developed a novel spatial data mining (DM) algorithm to identify significant spatial colocation rules of combinations of emitted chemicals and ABO (i.e., preterm birth [PTB], small for gestational age [SGA], and low birth weight at term [LBWT]). We used a Geographic Information System (GIS) to assign exposures to residences within 10 km of emission sites. We used epidemiological analysis to calculate the corresponding odds ratios of exposures to chemical mixtures and the occurrence of ABO, adjusted by maternal covariates and SES. DM distinguished five rules combining three chemicals - gases, particulate matter and organics - associated with ABO. GIS assigned exposure and epidemiological analysis identified all rules with increased odds for induced PTB, four for SGA, and only two for LBWT. The combined interdisciplinary use of data mining, GIS, and epidemiology strategies enabled us to generate new hypothesis by identifying the risks associated with mixtures of hazardous chemicals and ABO - findings that proved elusive when applying methodologies individually. These discoveries enhance our understanding of the role of chemical mixtures in ABO.

### **002.03.53. Associations of PM2.5 Source Concentrations with Childhood Asthma Emergency Department Visits in the U.S. State of Georgia: A Case-Crossover Study**

Mengjiao Huang

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**Abstract:** Background A novel hybrid air quality model that provides complete spatial coverage of PM2.5 source concentrations throughout the U.S. State of Georgia was used to investigate associations of air pollution sources with childhood asthma exacerbations. Objectives Estimate and compare associations of 12 PM2.5 source concentrations (i.e., contributions of emissions from motor vehicles, power plants, etc. on PM2.5 concentrations) with childhood asthma Emergency Department (ED) visits. Methods ED visits for asthma or wheezing (N=122,414) among children and adolescents (age ≤18 years) were obtained from patient claims records (in 2005 and 2007). Daily average PM2.5 concentrations from 12 sources were estimated using a hybrid chemical transport (CTM)-receptor model fused with observations from stationary monitors. In the case-crossover study, odds ratios for 3-day moving average PM2.5 concentrations were estimated using conditional logistic regression, matching on day-of-week and month, and adjusting for average temperature (3-day moving average), water vapor mixing ratio (3-day moving average), and Federal holidays. Results We observed positive associations between several PM2.5 sources and asthma ED visits. For example, per interquartile range increase in the source contribution, odds ratio estimates were 1.014 (95% CI: 1.008, 1.020) for dust; 1.029 (95% CI: 1.020, 1.039) for metals, and 1.044 (95% CI: 1.027, 1.063) for natural gas. These sources comprise 5.2%, 2.2%, and 6.5% of total PM2.5 mass, respectively. Heterogeneity in odds ratios across sources could reflect differences in the importance of sources in triggering asthma exacerbations. Because the CTM has uncertainties in the emissions and meteorology inputs and in the modeling of atmospheric processes, such conclusions are tentative. Conclusions Short-term increases in the concentrations of PM2.5 from several sources were associated with increases in childhood asthma ED visits.

## **O02.03.54. Long-Term Exposure to Industrial Air Pollution Emissions and the Incidence of Childhood Asthma: The Use of a Population-Based Birth Cohort and Dispersion Modeling**

Audrey Smargiassi

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**Abstract:** Studies on the effects of ambient air pollution have mostly focused on road traffic emissions and have mainly been performed in urban areas. We assessed the association between exposure to ambient concentrations of fine particles (PM<sub>2.5</sub>) and sulfur dioxide (SO<sub>2</sub>) resulting from industrial emissions and asthma onset in children of the province of Quebec, Canada. We used a population-based birth cohort developed from administrative health databases that comprised all children born in Quebec between March 2002 and March 2011. Using industrial emissions reported to the National Pollutant Release Inventory and hourly meteorology, we modelled yearly ambient SO<sub>2</sub> and PM<sub>2.5</sub> concentrations with the dispersion model CALPUFF at a fine spatio-temporal scale. Separately for each pollutant, we assessed associations between modelled yearly concentrations of PM<sub>2.5</sub> and SO<sub>2</sub> at the residence of children and the onset of asthma using Cox model with age as the timescale, adjusted for sex, calendar year and Pampalon's material and social deprivation index. The cohort includes 722,667 children of whom 66,559 developed asthma between 2002 and 2011. Preliminary analyses using yearly exposure estimates from 2009-2010 and including 18,392 incident cases of asthma showed positive association for both air pollutants. For an increase equal to the median of SO<sub>2</sub> and PM<sub>2.5</sub> levels, mean percentage changes in the risk of asthma onset was 5.7% (95%CI: 5.2, 6.2%) and 1.6% (95%CI: 1.2, 2.1%), respectively. However, departure from linearity was noted toward the highest levels of exposure. Future work will include additional years of exposure and indirect adjustment for secondhand smoke exposure. The independence of effects of industrial emissions from those of regional background pollutant levels also deserves further consideration. **Acknowledgments:** This work was supported by a contract with Health Canada.

## S02.03A. Advances in Assessment of Dermal Exposures and Absorption

### S02.03.01. Exploring the Use of Dermal Maximum Flux for Chemical Risk Assessment

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Abstract: Under Canada's Chemicals Management Plan, numerous assessments have been published over the last decade often including quantitative estimation of dermal exposure. Dermal exposures are often drivers of overall exposure. Dermal absorption is a key parameter for refining such exposure estimates. While chemical-specific empirical absorption data are preferred, such data are often lacking and approaches to estimate dermal absorption are often considered. One such approach is the Dermal Maximum Flux ( $J_{max}$ ) Approach.  $J_{max}$  is the steady-state flux of a substance across the skin when present at its solubility limit in the applied vehicle. It is calculated using the dermal permeability coefficient ( $K_p$ ) and the solubility of a substance both in the same vehicle.  $J_{max}$  is combined with the contact area and exposure duration of a given scenario in a risk assessment to calculate a theoretical upper-bound amount absorbed ( $Q_{max}$ ). The Dermal  $J_{max}$  Approach has been gaining traction in the literature due to its alleged conservatism, with some validation having been conducted for cosmetics and fragrances. To further explore the potential suitability of this approach from a regulatory perspective, a large-scale analysis will be presented comparing calculated  $Q_{max}$  values to around 1500 empirical amounts absorbed compiled from the publicly available literature for around 280 substances, spanning a wide range of chemical classes. The presenter will also discuss the utility of the Dermal  $J_{max}$  Approach as an alternative approach, including criteria for its application in human health risk assessments.

### **S02.03.02. Approaches to Assess Dermal Exposure and Absorption within U.S. EPA's Office of Pollution Prevention and Toxics (OPPT)**

Eva Wong

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Abstract: US EPA's Office of Pollution Prevention and Toxics (OPPT) assesses worker, general population, and consumer exposures to industrial chemicals in its new and existing chemicals programs under the Frank R. Lautenberg Chemical Safety in the 21st Century amendments to the Toxic Substances Control Act (TSCA). When evaluating chemical uses, OPPT uses measured data if available, modeling approaches, or a combination of both to estimate exposures. Activities during manufacturing, processing and use of industrial chemicals can result in dermal exposure to workers whereas use of consumer products and articles can result in dermal exposures to consumers in residential settings. In the absence of measured data for dermal exposure, assessments are often based on modeled estimates. Depending on the chemical specific data available, models that may be utilized for estimating potential dermal exposure include the Chemical Screening Tool for Exposures and Environmental Releases (ChemSTEER) in combination with generic scenarios, the Exposure and Fate Assessment Screening Tool (EFAST) or the newly updated Consumer Exposure Model (CEM). In the absence of dermal absorption data, potential absorption of the chemical from the skin can be based on data for analogous chemicals or on the chemical's physicochemical properties. This presentation provides an overview of approaches and available models for assessing dermal exposures within OPPT. The views expressed in this abstract are those of the authors and do not represent Agency policy or endorsement.

### **S02.03.03. Development of a Mechanistic in Silico Multiscale Framework to Assess Dermal Absorption of Chemicals**

Jan Urbanus

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Abstract: Available models for prediction of dermal exposure of increasing complexity will be discussed for use in regulatory chemical risk assessment, along with a characterization of the model data requirements and model limitations, and a work flow will be recommended to address the needs of the chemical risk assessment and in particular of the need to demonstrate safe use where internal exposure following dermal uptake remains below the target level.

#### **S02.03.04. Evaluation of in Silico Tools for Dermal Absorption Prediction**

Dimitra Eleftheriadou

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**Abstract:** A comprehensive literature search was performed identifying and describing existing in silico models to predict skin absorption. The search was performed on Scopus, PubMed and Toxline. A total of 2212 publications on the subject were identified. Then a two-tiered approach was applied to assess relevance of the publications, starting with an evaluation of title and abstract followed by a review of the full text. From 142 original research publications considered relevant after scientific review, a list with a total of 175 potentially reconstructable models was collected. The majority of models (78 %) were developed to predict dermal absorption of single substances and 38 models were identified predicting absorption of substances from simple mixtures. The models were based on a large number of different descriptors. A set of 11 models was selected to be evaluated regarding their ability to predict dermal absorption of pesticides. The selection comprised different types of models: single substance and mixture algorithmic models, single substance and mixture Artificial Neural Network models, and a single substance comprehensive transient model. The models were implemented based on the active substances'/products' physical/chemical information listed in EFSA's publicly available dataset. For some models additional descriptors had to be computed. To assess the accuracy of the computed predictions, the results of each model were compared to their respective in vitro results from the dataset (sample size up to 6842, depending on model). Model averaging of the full or of a selected set of models is examined as an alternative approach for more accurate predictions. The influence of a range of factors on the predictive quality of the models is assessed. Finally, the potential applicability of the evaluated models in a regulatory framework for evaluating systemic exposure to pesticides via the dermal route is discussed. Project funded by EFSA (OC/EFSA/PRAS/2016/02)

## **S02.03.05. New Developments Concerning Measurements of Occupational Dermal Exposures**

Dag Rother

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Abstract: The results of two projects initiated and funded by BAuA on measurement of occupational dermal exposure will be presented. One project is SysDEA (Systematic analysis of dermal exposure to hazardous chemical agents at the workplace). It is in essence a comparative study of different measurement methods for occupational dermal exposures under highly standardized conditions. The overall objective of this study was to generate scientific knowledge that forms the basis for improvements and standardization of measurement methods for dermal exposure to chemicals at the workplace. For more information regarding SysDEA you can check the relevant homepage: <https://www.baua.de/EN/Tasks/Research/Research-projects/f2349.html> The other project is also a comparative study on dermal and inhalation exposure of workers and bystanders during pest control of Oak Processionary Moth (OPM) by spray application. (Existing exposure data from plant protection activities in orchard or vineyards did not seem suitable for extrapolation to oak trees (which may be >20 m)). Also for the OPM-project information is online available: <https://www.baua.de/EN/Tasks/Research/Research-projects/f2343.html>

## S02.03B. Embracing Complexity: Frontiers in High-Resolution Air Pollution Exposure Assessment

### **S02.03.07. Estimating Human Exposure to Air Pollution in High Rise Cities: The Hong Kong D3D Study**

Benjamin Barratt

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Abstract: High density high rise cities have become a more prominent feature globally and air quality is a significant public health risk in many of these cities. As the spatial resolution of exposure assessment at ground level improves, there is an increased need to better understand vertical variation in air pollution, or risk overestimating the exposure of those who live on higher residential floors. Results will be presented from the Hong Kong D3D Study, which aimed to combine (i) a bespoke two dimensional air pollution model, (ii) a comprehensive vertical pollutant monitoring campaign within urban street canyons and (iii) a travel behavior survey to create a dynamic three dimensional (3D) population exposure model. A staged approach was used to quantify mortality risk estimates for an elderly cohort of 66,000 Hong Kong residents. The results from the study provided the first evidence that considering air pollution exposure in a dynamic 3D landscape would benefit epidemiological studies. Higher hazard ratios and a greater number of significant associations were found between mortality and pollutant exposures that would not have found had standard 2D exposure models been used. Dynamic models can also identify differential exposures between population subtypes. Improved urban building design appears to be stimulating the dispersion of local transport related air pollutant emissions in street canyons. Conversely, infiltration factors found in naturally ventilated buildings were high and residences provided little protection from ambient air pollution. This study demonstrated the benefits of dense sensor networks for characterizing human exposure in epidemiological studies. However, shortcomings of sensor technology were also found, where certain sensor types fell short of the required accuracy and precision to detect subtle gradients in pollution levels.

### **S02.03.08. Spatial Patterns of Exposures to Nontraditional Pollutants: Source Resolved Organic Aerosol and Ultrafine Particles**

Albert Presto

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**Abstract:** Background: Quantification of spatial variations in air pollutant concentrations often focus on time-integrated samples of EPA criteria pollutants such as NO<sub>2</sub> and PM<sub>2.5</sub>. This approach does not directly inform the sources driving variations in pollutant concentrations, nor does it capture sub-daily temporal variations characteristic of dynamic pollutants such as ultrafine particles (UFP) or source-resolved PM<sub>2.5</sub>. Methods: We deployed an aerosol mass spectrometer (AMS) in a mobile laboratory and measured UFP concurrently in the mobile laboratory and with a network of fixed samplers. AMS provides real-time measurement of PM composition between organic and inorganic fractions, as well as full aerosol mass spectra of organic PM. Factor analysis of organic aerosol mass spectra allows for quantification of the contributions of both fresh emissions (e.g., traffic and cooking emissions) and aged secondary PM. Results: Variations in PM exposure are largely driven by proximity to fresh emissions sources, including traffic and cooking, with the relative importance of these sources varying with land use patterns. Average population weighted exposures to total traffic PM, the sum of contributions from organic aerosol and black carbon, was approximately 1  $\mu\text{g m}^{-3}$  above the regional background, with higher concentrations in high-traffic areas. Population-weighted exposures to cooking PM, which is almost entirely composed of organic aerosol, was approximately 0.5  $\mu\text{g m}^{-3}$ . Concentrations vary temporally, with higher traffic contributions in the morning and cooking dominating at midday and evening. Conclusions: Fresh emissions from cooking and traffic drive spatial variations in PM concentration in urban areas. Traffic remains the largest contributor to fresh PM emissions, though cooking emissions are also important. For organic PM, cooking is a larger source than traffic.

### **S02.03.09. A Dense Sensor Network to Characterize Community Exposure to Black Carbon**

Chelsea Preble

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**Abstract:** We developed a low-cost black carbon (BC) sensor and deployed over 100 of them as a connected air quality network in West Oakland, California. The West Oakland residential community is adjacent to port and rail facilities and surrounded by major freeways. As such, the community is affected by diesel particulate matter emissions from heavy-duty diesel trucks, locomotives, and ships associated with freight movement. In partnership with community stakeholders, we positioned BC sensors outside of residences and businesses, along truck routes and arterial streets, along the Port of Oakland boundary, and at upwind locations. We operated this first-of-its kind BC air quality network for 100 days in summer 2017 in conjunction with a complementary study of on-road air pollution mapping. Spatiotemporal patterns in BC concentrations in West Oakland are observed to be driven by truck activity within the community. Highest concentrations exist along truck routes, near trucking facilities, and around businesses that use trucks to transport goods and materials. Almost everywhere, BC concentrations are higher on week-days than weekend-days, as is truck activity. The community-average BC concentration matches well the concentration measured at a centrally located site operated by the Bay Area Air Quality Management District. However, on average, 75% of locations within the community are more polluted than the central monitoring site, with daytime average BC up to 1.75× higher. Daytime average BC concentrations along the Port of Oakland boundary and designated truck routes around the community are up to 3× higher than the central monitoring site average. Overnight, the spatial gradient within the West Oakland neighborhood diminishes, such that BC concentrations are more uniform. Areas downwind of the freeway, along the Port of Oakland boundary, and at some trucking facilities have persistent elevated BC concentrations in the evening and early morning hours.

### **S02.03.10. Mapping Air Pollution with Google Street View Cars: Towards Efficient Mobile Monitoring**

Kyle Messier

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**Abstract:** Air pollution measurements collected through systematic mobile monitoring campaigns can provide exposure data at high spatial resolution. Approaches to minimize the amount of data and driving effort required to successfully map an urban area's air quality may help improve the scalability of this measurement approach. We explore the data requirements for mapping a city's air quality using mobile monitors utilizing "data only" and predictive model approaches. We used two Google Street View cars with fast-response (1 Hz) instruments to collect nitric oxide (NO) and black carbon (BC) measurements in Oakland, CA. This rich dataset incorporates ~ 3.6 million measurements collected repeatedly (20-50 ×) on every city street over 2 y. We explore two alternative strategies to efficiently mapping spatial air quality patterns. First, we use a "data-only" approach where we attempt to minimize the number of repeated visits to each road. Second, we combine our data with a land use regression-kriging (LURK) model to predict at unobserved locations, and consider sampling schemes where only a subset of a city's roads or repeat visits are measured. In all cases, we use a Monte Carlo scheme to systematically subsample the full dataset. LURK models consistently captured general spatial trends in urban air pollution, with cross-validation R<sup>2</sup> for log-transformed-NO and BC of 0.65 and 0.5. While LURK models did not capture the full variability of on-road concentrations, models could successfully be trained with minimal data requirements, e.g., with only a small number of repeated observations on ~20% of the roads. Data-only mapping performed poorly for < 4 repeated drives per road segment, but obtained surpassed the performance of LURK approach within 4 to 8 repeated drive days per road segment. Data-only mapping can have surprisingly modest data requirements. LURK models can efficiently produce valid predictions of air quality when it is not possible to sample air quality on every road.

### **S02.03.11. Use of Low-Cost Air Pollution Sensors in the Adult Changes in Thought Air Pollution Study**

Lianne Sheppard

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Abstract: Incorporating modern air pollution sensor technology into epidemiologic cohort studies is appealing because of its low cost, allowing much better spatial representation of pollution exposure. Exposure sampling design can also leverage emerging understanding from measurement error correction methods that the monitoring network design should be spatially compatible with the locations where the health study participants live. However, research has not yet been conducted to determine whether these low-cost sensor data are reliable, accurate, and consistent enough to use for epidemiological study exposure assessment. Our scientific goal is to estimate individual-level long-term average exposures to PM<sub>2.5</sub> and oxides of nitrogen for inference about the effects of air pollution on brain health. To accomplish this we are developing new spatio-temporal pollution predictions based on recently collected low-cost sensor data combined with existing ambient monitoring data. I will discuss the necessary quality control criteria for using the low-cost sensor data in a spatio-temporal prediction model, including calibration of these measurements to federal reference measurements. I will present the improvement in the performance of the spatio-temporal predictions from adding the low-cost sensor data and discuss the implications of these results for improving inference from epidemiologic cohort studies such as the Adult Changes in Thought Air Pollution study.

S02.03C. Fossil Fuels, Environmental Epidemiology, and the 2008 UN Declaration on the Rights of Indigenous Peoples (UNDRIP)

**S02.03.13. Oil Extraction in the Coastal Basin of the Democratic Republic of the Congo: A Pilot Study**

Benoit Nemery

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Abstract: Following concerns, voiced by the local population and NGOs, about the consequences of the on-shore oil extraction along the Atlantic Ocean north of the Congo River estuary, the health authorities of the DR Congo requested a multidisciplinary team to conduct a pilot study to evaluate the possible environmental and human health impact of this activity. The field study was conducted during the last week of December 2015 (rainy season) by a team of experts in environmental health, toxicology and biology, with help from local health workers. Environmental samples (soil, air, water, fish) were collected in relevant locations close to or within oil extraction fields, as well as in a control area. Spot samples of urine were also obtained from 34 adults and 19 children living at various distances from oil extraction sites (convenience sampling). Concentrations of hydrocarbons (or their metabolites) and metals were later measured in the environmental and urine samples. This limited study did not find evidence of major environmental degradation or high human exposure to toxic agents in relation to on-shore oil extraction in the studied area. These findings do not imply that oil extraction can be done anywhere without risks for the environment or human health.

## **S02.03.14. Oil Extraction in the Amazon Basin and Levels of Metals among Indigenous Populations**

Cristina O'Callaghan-Gordo

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- 6. E-Tech International, Santa Fe, NM, United States.*

**Abstract:** Between May and August 2016 the Peruvian Ministry of Health conducted a cross-sectional study to assess levels of exposure to metals in the local population and establish risk factors in Corrientes, Pastaza, Marañón and Tigre river basins (Peru). 1168 people from 39 indigenous communities participated in the study. Information on socio-demographic variables and environmental exposures was collected in questionnaires. Blood and urine samples were collected from each study participant, and environmental samples were collected from each community to measure levels of metals and hydrocarbons. We used atomic absorption spectrophotometry to measure metals concentrations (Pb, As, Ba, Cd and Hg) in biological and environmental samples. We used multilevel mixed-effects linear regression models with a random effect for community and river basin, adjusted for potential confounders to study the association between socio-demographic variables and environmental exposures and levels of metals in biological samples. We used linear regression models to study the association between median concentration of metals on environmental samples and on biological samples at the community level. 57% of the study population had blood lead levels above 5 µg/dL and 28%, 13%, 9% and 26% of the study population had urinary levels of As, Ba, Cd and Hg, respectively, higher than those recommended by the Peruvian Ministry of Health (20 µg Cd/g As, 6 µg Ba/g creatinine, 2 µg Cd/g creatinine and 5 µg Hg/g creatinine). There were differences in levels of metals in environmental samples according to river basin. Inhabitants of communities with higher levels of Cd in agricultural soil presented higher levels Cd urinary levels than inhabitants from other communities. The analysis of risk factors at the individual level did not yield clear results. Differences in level of exposure to metals were generally explained by ethnic group, which might reflect geographical differences in levels of exposure.

### **S02.03.15. Cultural Strength, Connection to Land, Social Justice and the Adani Carmichael Mine: Placing Aboriginal Health and Wellbeing Front and Centre in Mining Decisions in Australia**

Melissa Haswell

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*2. Indigenous Health Discipline, Graduate School of Health, University of Technology Sydney, Sydney, NSW, Australia.*

Abstract: The harvesting of Australia's massive mineral reserves began the 1840's; 50 years after Captain Cook landed in Botany Bay, driving massive population influx, environmental degradation and forced evacuation of Aboriginal homelands and communities. Today, the impacts of fossil fuel mining continue to disturb the physical, social and emotional, spiritual and cultural wellbeing and community cohesion of Aboriginal Australians. These First Australians already experience enormous inequalities in health, social and economic status, as well as transgenerational trauma from widespread death, systematic removal from Lands and disempowerment of family and culture since 1788. Today's Australian focal point of environmental activism is opposition to the \$16.5 billion Adani Carmichael mega-mine proposal to extract 6.3 billion tons of coal over 60 years from the Traditional Lands of the Wangan and Jagalingou people. Highlighting contravention of the UN Declaration on the Rights of Indigenous Peoples endorsed by Australia in 2009, Traditional Owner Adrian Burragabba warns, they will stop our dreaming. where will the song go; what will the song be; there will be nothing left. [but] we are still here and no still means no. Now is the time to stand stronger than ever to step up to the fight. Like most Indigenous Peoples, Aboriginal Australians recognise inseparable connections between the health of Land and its people. This talk examines benefits to epidemiologists in understanding the importance of social, emotional and spiritual wellbeing as a foundational environmental health determinant. We focus on principles developed by Aboriginal Australians (NHMRC Roadmap) to ensure that research strengthens health, spirit and integrity. We argue that these must underpin urgently needed research partnerships to improve health impact assessment with Aboriginal people facing destruction of their Lands and enforce deeper consideration in government decisions on fossil fuel developments.

## **S02.03.16. Documenting Complex Air Pollution Mixtures and Baseline Health Conditions in Fort McKay, Alberta**

Jeffrey Brook

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- 4. Fort McKay Sustainability Department, Fort McKay First Nation, Fort McKay, AB, Canada.*
- 5. Fort McKay First Nation, Fort McKay, AB, Canada. 6. McMaster University, Hamilton, ON, Canada.*

Abstract: Environmental pollution from the oil sands industry in northern Alberta, Canada, is an ongoing concern. Fort McKay is an Indigenous community in close proximity to these sources. To improve understanding of the impacts of the air emissions on the environment and the community, detailed air monitoring was initiated by Environment and Climate Change Canada in 2013. Subsequent to this, but independent from it, Fort McKay joined a national Indigenous cohort which is sub-study of the Canadian Alliance for Health Hearts and Minds (CAHHM). In total 104 participants aged 18 to 69 years residing in Fort McKay were recruited, providing individual information via multiple questionnaires (medical history, risk factors, diet, physical activity), and via physical and cognitive measures and blood samples (hemoglobin A1C and Apolipoproteins). Consistent with the CAHHM national protocol, a majority (N=87) of the Fort McKay participants underwent Magnetic Resonance Imaging (brain, heart, carotid and abdomen), consented to follow-up via health record linkage and to blood storage for possible genetic research with further consent. Community-level environmental contextual factors were also assessed. Establishing this strong baseline of health data and community engagement within the broader context of a national study is expected to enable research on a range of health questions geared towards a better understanding of why Indigenous people have higher rates of death from CVD compared to the Canadian population, and how, through community-based approaches, this burden can be reduced. Potential health impacts of long-term air pollutant exposures can also be explored given the national CAHHM platform. The purpose of this presentation will be to provide an overview of this work to date, including community air pollutant exposures, challenges and opportunities.

## **S02.03.17. Tar Sands Operations and Waterborne Exposure and Subsistence Food Supply in Canada**

Eriel Deranger

*Eriel Deranger<sup>1</sup>*

### *1. Indigenous Climate Action, Edmonton, AB, Canada.*

Abstract: The political divide surrounding the development of the Alberta oil sands has created escalating tensions between political leaders, Canadian citizens and Indigenous communities alike. Indigenous communities at the centre of this debate cite historical denial of inherent, Treaty and international rights, via exclusion from permitting, development and regulation of the oil sands. To date Alberta oil sands have contributed to the disturbance of over 500 km<sup>2</sup> of boreal and peatlands in the Athabasca River watershed, contributing to the irreversible transformation and contamination of traditional lands and water systems. There is increasing evidence of polycyclic aromatic hydrocarbons and other toxicants entering water systems and contaminating food systems (ie. fish, migratory birds, small and large mammals). Continued expansion of Alberta oil sands undermines Indigenous rights to protect land, food, water and medicines and raises concern of multi-generational impacts (environmental, health, socio-economic, and Indigenous rights). The presentation will explore western science and Indigenous science studies highlighting downstream Indigenous communities concerns of contamination of critical water systems created via Alberta's oil sands; how recognition of Indigenous rights are essential to policy and regulation of the industry; and overall impacts of extractive industries on local Indigenous people efforts to implement international rights standards under UNDRIP (ie. Free, Prior and Informed Consent).

### **S02.03.18. Environmental Injustice: Local (Environmental Contamination) and Global (Climate Change) Effects from the Use of Fossil Fuels on Those Who Benefit Least from Their Use**

Adetoun Mustapha

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Abstract: Continuing carbon emissions and the associated consequent rise of mean global temperatures from the combustion of fossil fuels has had and will continue to have profoundly worsening implications in resource-constrained regions of the world. Most communities in industrializing/developing parts of the world live in climate-sensitive locations and most economies in such regions depend on natural resources. Ongoing degradation of natural resources from human activities and reduced agricultural productivity are worsening with climate change and will continue to make these regions uninhabitable, affecting poverty trajectories and migration patterns on a massive scale. This discussion reviews environmental episodes among indigenous peoples, their ethical dimensions, and identifies mitigation strategies to protect these vulnerable communities. Although growth in gross domestic product in theory is supposed to result in a rise in population standards, in practice, with the ever widening gulf between rich and poor, the net-negative effects fall on those who benefit least from the continued use of fossil fuels. A paradigmatic shift is needed, especially focused on respect for local community sustainability.

S02.03D. The European Human Biomonitoring Initiative HBM4EU: Harmonizing Exposure and Health Risk Assessment in Europe to Support Science and Policy  
**S02.03.19. Integrated Exposure Modeling for Human Biomonitoring Data Assimilation**

Dimosthenis Sarigiannis

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**Abstract:** The integrated exposure assessment framework in HBM4EU aims at introducing a comprehensive methodological approach which will be implemented in a computational platform. The aim is to assess the source-to-dose continuum of a large space of chemical substances, towards the effective assimilation of human biomonitoring (HBM) data. The platform will integrate environmental fate, exposure and internal dose dynamically in time and across different spatial resolutions (from local to global). This description requires the use of multimedia environmental and micro-environmental modelling, exposure analysis incorporating multiple pathways and routes of exposure, and Physiology Based Toxicokinetic (PBTK) modelling. Exposure analysis up to internal dose, will allow the interpretation of actual dosimetry to target tissues to in vitro assay results. This is of particular importance for the precise estimation of doses that relate to molecular perturbations within adverse outcome pathways (AOPs). Biomonitoring data interpretation is another challenge of the methodology, described as the "reverse modeling" calculations for exposure reconstruction. Following this, and based on the amount and quality of prior information, quantitative predictions, ranging from the overall exposure burden up to pathway/route specific information could be made; this will provide a very comprehensive instrument for policy makers, that will allow them to point out the cost-efficient interventions (which sources contribute mostly to exposure), directly from HBM data. The applicability of the methodology has been demonstrated in the case of bisphenol-A, Exposure reconstruction of available HBM data resulted in very low intake estimates, while the use of in vitro data regarding its estrogenic activity, indicated that there is no reason for concern for individual or aggregate scenarios of BPA exposure in the EU population.

## **S02.03.20. Complementary Strategies for Suspect and Untargeted Screening of Emerging Substances in Human Matrices**

Jean-Philippe Antignac

*Jean-Philippe Antignac<sup>1</sup>, Ronan Cariou<sup>1</sup>, Alexis Leon<sup>1</sup>, Sébastien Hutinet<sup>1</sup>, Mariane Pouchet-Gellez<sup>1</sup>, Yann Guitton<sup>1</sup>, Bruno Le Bizec<sup>1</sup>*

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**Abstract:** The emerging chemicals challenge clearly appears as a major current concern for the scientific community, societal actors, and public authorities. However, this issue still remains imperfectly defined and may cover different aspects both from a conceptual and methodological point of view. In the scope of the HBM4EU project and its related WP16, emerging chemicals should be understood as chemicals of emerging concern. These emerging substances are not yet included in existing HBM programs, mainly due to the absence of analytical methods available to determine the considered chemical or its metabolites in human specimens. For this reason, new approaches permitting to analyse these compounds in the broadest way are mandatory. Current mass spectrometric instrumentation, especially high resolution devices, offers a great opportunity to develop such extended suspect or untargeted screening methods from various human biological material. In addition to these chemistry driven approaches, Effect-Directed Analysis (EDA) approaches can be also useful for performing a biological activity driven screening. All together, these approaches aim to address the complex question of emerging substances using complementary angles respectively based on exposure assessment and hazard characterization. Finally, their combination is expected to contribute to risk assessment and support to policy by providing data related both to the reality of human exposure and to the potential toxicity of the considered substances. All these different approaches for untargeted screening will be developed and applied within the HBM4EU WP16.

### **S02.03.21. HBM4EU Mixtures, Human Biomonitoring and Human Health Risk: Methods to Describe Mixture Exposures in the European Population Based on Human Biomonitoring Data**

Erik Lebret

*Erik Lebret<sup>1</sup>, Ilse Ottenbros<sup>1</sup>, Rik Bogers<sup>3</sup>, Jelle Vlaanderen<sup>2</sup>, Roel Vermeulen<sup>2</sup>*

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- 3. RIVM, Bilthoven, Netherlands.*

Abstract: Humans are exposed to a myriad of concurrent and protracted environmental, occupational, dietary, lifestyle and consumer product exposures. These mixtures of exposure can form an almost infinite number of different combinations of chemicals, which makes the risk assessment extremely challenging. The term mixture (in the context of human biomonitoring) is used to describe any combination of exposure of internal dose biomarkers that has been measured in one or more biological matrices of a person during a single time point. These biomarkers include the chemical substances themselves, as well as their metabolites. The mixture might include compounds from multiple substances groups, but also from multiple compounds from the same substance group. One of our main research questions is "What patterns can we observe amongst body burdens of different substances within individuals, and can we identify hotspots or risk groups with high body burdens of mixtures and/or high mixture risks?" Understanding the correlation patterns, latent structures and functional networks of these mixtures of exposure could provide information on the occurrence of mixtures, common sources and routes of exposure. Such occurrence information is pivotal in mixture risk assessment. Distributions of (patterns) in biomarker mixtures across Europe will be described based on available human biomonitoring datasets. These distributions can be stratified by determinants such as country, region, sampling period, personal characteristics, etc. Using network visualization tools and differential network analyses, we explored similarities and differences in network structures in available human biomonitoring datasets. During this presentation the methods of the network visualization and differential network analysis will be presented.

## **S02.03.22. Communication in HBM4EU and Sustainability Post 2021**

Catherine Ganzleben

*Catherine Ganzleben<sup>1</sup>*

*1. European Environment Agency, Copenhagen, Denmark.*

Abstract: The presentation will describe the strategy for the communication and dissemination of HBM4EU results. Effective and targeted dissemination of HBM4EU outputs is crucial to ensuring that key audiences both understand and use our results for the protection of human health. Our target audiences include policy makers, the scientific community, NGOs, industrial representatives, trade unions and members of the public, with each having distinct demands for knowledge on chemical exposure. In particular, the effective communication of results to risk assessors and risk manager via tailored communicated products is essential to building a bridge between science and policy. The long-term aim of developing the architecture and securing the funding and political will for a sustainable human biomonitoring initiative in Europe will also be addressed.

### **S02.03.23. HBM in Human Risk Assessment and Health Impact Assessment: Translation of Results into Policy**

Jos Bessems

*Jos Bessems<sup>1</sup>, Greet Schoeters<sup>1</sup>, Tiina Santonen<sup>2</sup>*

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*2. FIOH (Finnish Institute of Occupational Health), Helsinki, Finland.*

Abstract: This presentation will focus on major activities in HBM4EU Work Package 5 'Translation of results into policy'. Starting point is a number of limitations with respect to the HBM (human biomonitoring) instrumentation but also in knowledge and acceptance of HBM in human risk assessment (HRA) and human health impact assessment (HIA). So there are quite some challenges related to it. Following a wide survey in the EU, needs were identified for the better inclusion of HBM in HRA and HIA practices. A first clear need are health-based HBM guidance values as indicative internal limit values, necessary to use exposure biomarker results in preliminary risk assessments. A second need is better regulatory incorporation (clearer legislative role) of HBM but also guidance on the 'when' and 'how' and the 'pros', 'cons' as well as caveats that go with the use of HBM in HRA and HIA. A third one is better communication with risk managers and policy makers, a topic for which easy understandable HBM-based indicators are being established. A last one is a stepwise approach on how to involve stakeholders in the scientific, policy and societal (citizens) arena in order to reach awareness, acceptance and generation of HBM data but also science- and participatory-approach based chemical policy recommendations.

## **S02.03.24. HBM4EU: The European Human Biomonitoring Initiative**

Marike Kolossa-Gehring

*Marike Kolossa-Gehring<sup>1</sup>, Ulrike Doyle<sup>1</sup>, Rosa Lange<sup>1</sup>, Kim Pack<sup>1</sup>, Lena Reiber<sup>1</sup>*

*1. German Environment Agency (UBA), Berlin, Germany.*

Abstract: HBM4EU follows an innovative approach to generate the knowledge policy makers need to improve policy in the field of environment and health. The overarching goal of HBM4EU is to generate new knowledge, to inform the safe management of chemicals, and consequently protect human health in Europe. Human Biomonitoring data supply information on the aggregated internal exposure from all sources and by all pathways. They will serve as the basis to assess the risks from human exposure to chemicals. Intensive communication and involvement with policy makers ensures that HBM4EU results are used in the further development and design of new chemicals policies and in the evaluation of existing measures. HBM4EU consists of 109 partner organisations from 28 countries - 27 European countries and Israel - and is organised around 16 work packages led by key players of national HBM studies and research programmes. It builds upon existing knowledge from national and EU monitoring and research programmes. Major fields of activities are the science to policy transfer, harmonisation of HBM studies, and research to elucidate the impact of exposure on health. HBM data are currently fragmented in Europe. Exposure data valid for the whole of Europe, the identification of vulnerable or highly exposed subpopulations and the analysis of spatial and temporal exposure trends are major goals of HBM4EU. HBM reveals the extent and quality of multiple chemicals exposures and demonstrates the need to develop concepts for health risk assessment beyond traditional single substance evaluation methods. The research program of the European Joint Project is based on the policy needs and priority chemicals identified after consultation with European and national policy makers. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733032.

## **S02.03.25. The Quality Programme for Assuring Comparability of Analytical Results in HBM4EU**

Argelia Castaño

*Argelia Castaño<sup>1</sup>, Marta Esteban<sup>1</sup>, Jean-Philippe Antignac<sup>2</sup>, Mónica Bartomé<sup>1</sup>, Daniel Bury<sup>3</sup>, Adrian Covaci<sup>4</sup>, Thomas Göen<sup>5</sup>, Jana Hajslova<sup>6</sup>, Monika Kasper-Sonnenberg<sup>3</sup>, Jana Klanova<sup>11</sup>, Holger M. Koch<sup>3</sup>, Christian Lindh<sup>7</sup>, Thomas Lund<sup>7</sup>, Hans Mol<sup>8</sup>, Susana Pedraza<sup>1</sup>, Jana Pulkrabova<sup>6</sup>, Juan José Ramos<sup>1</sup>, Line Småstuen Haug<sup>9</sup>, Cathrine Thomsen<sup>9</sup>, Katrin Vorkamp<sup>10</sup>*

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- 5. Institute and Outpatient Clinic of Occupational, Social and Environmental Medicine of the University of Erlangen-Nuremberg, Erlangen-Nuremberg, Germany.*
- 6. University of Chemistry and Technology, Prague, Czechia.*
- 7. Institute of Laboratory Medicine, University Hospital, Lund, Sweden.*
- 8. Wageningen University & Research, RIKILT, Wageningen, Netherlands.*
- 9. Norwegian Institute of Public Health, Oslo, Norway.*
- 10. Aarhus University, Aarhus, Denmark.*
- 11. RECETOX, Prague, Czechia.*

Abstract: The HBM4EU initiative is aiming to coordinate and advance human biomonitoring (HBM) in Europe. It will provide better knowledge of the actual exposure of citizens to chemicals, to support policy making. The initiative is a joint effort of 28 countries, of 109 partner organisations, co-funded under Horizon 2020 and will run from 2017 to 2021, building on previous activities undertaken at EU and national levels. HBM4EU will contribute to fill the data gaps for the exposure to prioritized chemicals, through chemical analysis of human samples in a harmonized way. Thus, a specific work package is dedicated to Laboratory analysis and quality assurance (QA). Specific tasks include the inventory and selection of best-suited biomarkers and matrices for the prioritized substance groups (three rounds of prioritization of chemical groups are planned along the project). The establishment of networks of HBM laboratories for biomarker analysis and support of the QA program at EU level, as well as for developing new methods on identified gaps. A Quality Assurance Unit (QAU) with experts in HBM chemical analysis has been established to assess the process and secure comparability of HBM4EU results. We have developed Standard Operating Procedures for guiding main aspects in the harmonization process of EU laboratories. An ambitious program for intercomparison laboratory exercises (ICI/EQUAS) has been designed with a total of 76 individual human biomarkers for the first round of priority substance groups (phthalates, flame retardants, poly- and perfluoroalkyl substances, polycyclic aromatic hydrocarbons, bisphenols, anilines, cadmium and, chromium). Candidate laboratories need to participate in at least three proficiency rounds and successful results in the ICI/EQUAS program is required for European labs to analyze HBM4EU samples. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733032.

## **S02.03.26. A Framework for the Collection of HBM Data in Europe to Study Spatial and Time Trends of Chemical Exposure in European Citizens**

Greet Schoeters

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2. Santé Publique France, Paris, France.
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4. Public Health England, London, United Kingdom.
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Abstract: The European Joint Programme HBM4EU is the backbone for knowledge on human exposure to environmental chemicals in the EU. It will inform European and national policy makers to take science based decisions for reducing chemical exposure of EU citizens to hazardous compounds. To answer policy questions on current EU-wide exposure to a selection of 8 priority substance groups, we have developed a framework for sampling which is based on existing and planned studies. The aim is to collect human biomonitoring data that will be comparable and hence allow to calculate reference values for Europe, to get information on the regional distribution of the priority chemicals in European citizens, and to evaluate the efficacy of EU and national policies. Current exposure is defined as exposure measured in samples collected between 2014 and 2019. To obtain comparable data from existing national and regional studies of 20 countries fieldwork and sampling protocols were developed to facilitate harmonisation. Biomarker analysis will be quality assured. As the importance and effective prevention of early life exposures is widely recognised, we focus in a first phase of HBM4EU on prepuberty, puberty and reproductive age groups. As such children between 6 and 11 years, teenagers between 12 and 19 years old and young adults between 20 and 39 years of age will be included in the first survey. Data will be collected and shared through the data platform IPCHEM, hosted at the EC Joint Research Centre (Ispra, IT). The survey will be an important step towards a sustainable HBM framework in the EU. At the same time biomolecular and advanced exposure modelling research will be grafted on this framework to better understand risks and health impact of exposure to environmental chemicals in Europe.

## O02.04A. Air Pollution, Pregnancy and Perinatal Health Outcomes

### O02.04.01. Time-Varying Exposure to Fine Particulate Matter and Black Carbon and Outcomes of In Vitro Fertilization

Audrey Gaskins

*Audrey J. Gaskins<sup>1</sup>, Kelvin C. Fong<sup>1</sup>, Yara Abu Awad<sup>1</sup>, Lidia Minguez-Alarcón<sup>1</sup>, Jorge E. Chavarro<sup>1</sup>, Brent Coull<sup>1</sup>, Joel D. Schwartz<sup>1</sup>, Russ Hauser<sup>1</sup>, Francine Laden<sup>1</sup>*

*1. Harvard T.H. Chan School of Public Health, Boston, MA, United States.*

**Abstract: Background/Aim:** Air pollution has been linked to decreased fertility yet the specific mechanisms and windows of susceptibility remain unclear. We examined the association between time-varying exposure to fine particulate matter (PM<sub>2.5</sub>) and black carbon (BC) on in vitro fertilization (IVF) outcomes. **Methods:** We included 356 women (537 cycles) for the PM<sub>2.5</sub> analysis (2005-2016) and 234 women (343 cycles) for the BC analysis (2005-2011) enrolled in a prospective cohort study of couples undergoing a fresh IVF cycle in New England. We used spatiotemporal models to estimate daily PM<sub>2.5</sub> and BC exposures (based on residential address) throughout the IVF cycle. Multivariable discrete time Cox proportional hazards models with 3 time periods (cycle initiation to embryo transfer (ET), ET to implantation, implantation to live birth) were used to estimate odds ratios (OR) and 95% confidence intervals (CI) of failing at IVF. Time-dependent interactions between exposures and IVF time windows were used to identify vulnerable periods. **Results:** An interquartile range (IQR) increase in PM<sub>2.5</sub> (3 µg/m<sup>3</sup>) and BC (0.2 µg/m<sup>3</sup>) throughout the IVF cycle was associated with a non-significant, elevated odds of failing at IVF prior to live birth (OR=1.15, 95% CI 0.96, 1.38 for PM<sub>2.5</sub> and OR=1.25, 95% CI 0.87, 1.78 for BC). The effect of PM<sub>2.5</sub> and BC exposure on IVF failure was strongest during the earliest windows of IVF. Specifically, an IQR increase in PM<sub>2.5</sub> and BC exposure was associated with 1.30 (95% CI 1.01, 1.67) and 1.55 (95% CI 1.15, 2.10) times the odds of failing prior to ET, 1.07 (95% CI 0.82, 1.39) and 1.18 (0.77, 1.80) times the odds of failing between ET and implantation, and 1.05 (0.59, 1.88) and 0.82 (0.43, 1.59) times the odds of failing between implantation and live birth. **Conclusion:** Increased exposure to PM<sub>2.5</sub> and BC during ovarian stimulation is associated with higher odds of IVF failure prior to ET. Acute exposure to PM<sub>2.5</sub> and BC may have adverse effects on oocyte development.

## **002.04.02. Air Pollution and Preterm Birth: Do Air Pollution Changes over Time Influence Risk in Consecutive Pregnancies among Low-Risk Nulliparous Women?**

Pauline Mendola

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Abstract: Both air pollution, generally decreasing in the U.S., and having a prior preterm birth (PTB) are risk factors for subsequent pregnancy PTB. To investigate whether air pollution exposures would have a potential differential effect on PTB risk in the first and second pregnancy among low-risk women, we estimated exposures based on modified Community Multiscale Air Quality models linked to the NICHD Consecutive Pregnancy Study. Electronic medical records for consecutive delivery admissions were available for 27,137 nulliparous women with singleton births in 20 Utah-based hospitals between 2002-10. We categorized whole pregnancy exposures based on percentiles as high (>75), moderate (25-75) and low (<25). Modified Poisson regression with generalized estimating equations estimated PTB risk in the second pregnancy associated with persistent high and moderate exposure, and increasing or decreasing exposure, compared to persistent low exposure. Analyses were adjusted for prior PTB, interpregnancy interval and other demographic and clinical characteristics. Pollution levels generally decreased over time, reducing the number of women with high second pregnancy exposure. Second pregnancy PTB risk was increased when exposure increased for sulfur dioxide (34%), ozone (80%), nitrogen dioxides (NO<sub>2</sub>; 38%), and carbon monoxide (CO; 33%) versus stayed consistently low. Similar trends were observed for consistently high versus consistently low exposure. We also observed significant interaction by prior PTB status. Women with no prior PTB had significantly higher risk associated with increasing levels of several pollutants as compared to women with prior PTB, including NO<sub>2</sub> (increase of 63% vs. decrease of 7%, p-interaction=0.004) and CO (increase of 57% vs. no change, p-interaction=0.031). These findings suggest area-level changes in air pollution exposure have important consequences in repeated pregnancies even among low risk women at moderate levels of exposure in the U.S.

### **002.04.03. Prenatal Exposure to CO and NO<sub>2</sub> and Reduced Term Birthweight: A Pilot Study Utilizing Hospital-Based Delivery Data for Environmental Health Research in New Delhi, India**

Shakoor Hajat

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**Abstract:** Background New Delhi is one of the most polluted cities in the world. Pregnant women are exposed to criterion air pollutants that are suspected to reduce birthweight. This study investigates the association of CO and NO<sub>2</sub> exposure to birthweight of term neonates born in New Delhi from 2007-2012 (N=10,565) using hospital-based data linked with 10 continuous air quality monitoring station (CAQMS) data reported by the Central Pollution Control Board. Due to the absence of a national birth registry in India, it is important to utilize existing hospital datasets for environmental health assessment studies. Methods 2007-2012 average levels of carbon monoxide (CO), and nitrogen dioxide (NO<sub>2</sub>) were obtained and linked to delivery data during the same timeframe in an urban hospital in New Delhi. Data from stations within 10 kilometres of maternal residence were assigned to each birth record. Multiple regression analysis was conducted to detect associations between levels of exposure to pollutants and term low birth weight. Results An interquartile range (IQR) increase in ambient pollutant concentrations of CO (580 ppb) and NO<sub>2</sub> (26 ppb) during the whole pregnancy was associated with a 19g (95% CI: -36, 2) and 18g (95% CI: -33, -3) decrease in birth weight, respectively, for all births. We assessed pollutant effects by trimester to identify biological exposure window of concern. For CO, the effect is most pronounced during the first trimester. An IQR increase in CO and NO<sub>2</sub> was associated with a 26g (95% CI: -50, -3) and 27g (95% CI: -48, -6) decrease in birth weight, respectively, in female births; results were not significant for male births. Conclusions Pregnant women and their neonates are exposed to high levels of CO and NO<sub>2</sub> in New Delhi. The medical community can contribute to the policy dialogue by utilizing hospital data for environmental health research. There is a need for a national birth registry to assess early exposures to pollutants and life course impact.

#### **O02.04.04. Maternal Exposure to Outdoor Air Pollution and Congenital Limb Deficiencies in National Birth Defects Prevention Study**

Giehae Choi

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**Abstract:** Background Congenital limb deficiencies (CLDs) are a relatively common phenotypic grouping of birth defects. Emerging evidence from recent studies suggests air pollutants as potential risk factors. Aim To investigate the relationship between ambient air pollution during early pregnancy and CLDs. Methods During 1997-2007, 595 cases of CLDs and 5,432 controls were identified from the National Birth Defects Prevention Study, a multi-center population-based case-control study. Weekly and overall averages of 6 criteria air pollutants (particulate matter <2.5µg/m<sup>3</sup> [PM<sub>2.5</sub>], PM<sub>10</sub>, nitrogen dioxide [NO<sub>2</sub>], sulfur dioxide [SO<sub>2</sub>], carbon monoxide [CO], and ozone [O<sub>3</sub>]) during gestational weeks 2-8 were estimated with EPA air monitors nearest to the maternal address recorded at birth. Logistic regression was used to estimate adjusted odds ratios (aORs) and 95% confidence intervals (CIs), considering potential confounders: maternal age, race/ethnicity, education, and study center. We additionally analyzed CLD subtypes (i.e., transverse, longitudinal, and intercalary), assessed modification by body mass index, cigarette smoking, folic acid use, and distance to air monitor, and adjusted for co-pollutants. Results We observed near-null adjusted associations between CLDs and PM<sub>10</sub>, PM<sub>2.5</sub>, and O<sub>3</sub>. However, weekly averages of the daily NO<sub>2</sub> and SO<sub>2</sub>, and daily maximum 1-hour CO concentrations were associated with increased odds of CLDs. The largest and most consistent effect was in CO (week 2 aOR: 1.13 per 1 ppm change, 95% CI: 1.00-1.27), with similar trends for CLD subtypes. The aORs for CO were elevated if mothers did not use folic acid or lived within 20km of an air monitor. The aORs for SO<sub>2</sub> were elevated if mothers were obese or were smokers. In co-pollutant models, CO was associated with elevated odds of CLDs (aORs: 1.02-1.30) and aORs for SO<sub>2</sub> and NO<sub>2</sub> were attenuated. Conclusion CO may be associated with CLDs, and further epidemiologic and mechanistic research is warranted. Disclaimer The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency, the Centers for Disease Control and Prevention, or the California Department of Public Health.

## **O02.04.05. Increased Risk of Infant Mortality Associated with Pre and Postnatal Exposures to PM2.5 in South Korea: A Propensity Score-Matched Analysis**

Eun Mi Jung

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**Abstract:** Background Evidence on the effect of pre and postnatal exposures to PM10 and PM2.5 on infant mortality is still scarce. We aimed to investigate exposures in six exposure periods (EPs) to explore the associations with infant mortality and their changes over time during pregnancy. **Methods** We used a 2010-15 retrospective birth cohort data obtained from Statistics Korea. We examined 5 cause-specific infant mortalities based on the ICD-10: sudden infant death syndrome (R95), circulatory (I00-99), respiratory (J00-99), perinatal conditions (P00-96), and congenital malformations (Q00-99). Out of 2,525,109 infants 1,530 deaths (0.06%) were identified. With propensity score matching stratified into quintile a 1:2 match was conducted, which was controlled for sex, gestational age, and city size (metropolitan/others). We calculated mean PM2.5 concentrations, using ground monitoring data and Community Multiscale Air Quality model for the following six EPs: each trimester (EP 1-3), gestational period (EP 4), postnatal period (EP 5), and whole period (EP 6; from conception to death). Models were adjusted for infant's address, maternal education level, maternal age, birth weight, and season of birth. A conditional logistic model was applied to take matching and stratification into account. **Results** Adjusted conditional logistic regression resulted in statistically significant associations between PM2.5 and infant death for all 6 EPs. A 1µg/m<sup>3</sup> elevation in PM2.5 concentrations was associated with 2% (95% CI, 1%-4%), 2% (1%-4%), 3% (2%-5%), 6% (4%-9%), 3% (2%-5%), and 15% (12%-19%) increase in infant mortality for ETs 1 to 6, respectively. **Conclusion** the study findings suggest that pre and postnatal exposures to PM2.5 could be a risk factor for infant mortality and that the association depends on the length of ET: The longer, the higher. Since the 5 causes were combined, further studies on each cause in relation with infant mortality are necessary as more data become available.

## O02.04B. Greenness Effects 1

### O02.04.06. Green Spaces and Cognitive Decline over 10 Years of Follow-Up in the Whitehall II Cohort

Cathryn Tonne

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**Abstract:** Cognitive function is one of the most important indicators of healthy ageing. Evidence on beneficial associations of green space with cognitive function at older age is scarce and mainly limited to cross-sectional studies. This longitudinal study investigated the association between long-term green space exposure and cognitive decline. The analyses were based on three waves of data from the Whitehall II cohort, providing a 10-year follow-up of 6506 civil servants (45-68 years old) from the UK. Residential surrounding greenness was obtained across buffers of 500 and 1000 meter around the participants' residential address at each follow-up using satellite images on greenness (Normalized Difference Vegetation Index, NDVI) from a summer month in each follow-up period. Four cognitive tests were repeated three times over the study period, assessing reasoning, verbal fluency, and short-term memory. The cognitive scores were standardized and summarized in a "global cognition" z-score. To quantify the impact of greenness on the repeated measurements of cognition, linear mixed effect models were developed that included an interaction between age and the indicator of greenness, and controlled for covariates including individual and neighbourhood indicators of socioeconomic status. An interquartile range increase in NDVI was associated with a difference in the global cognition z-score of 0.020 (95% confidence interval (CI): 0.003 to 0.037) over 10 years. Comparing study participants of 55.7 years old, this difference was equivalent to a 4.6% slower decline over 10 years. Similar positive associations were also observed for the separate cognitive scores of reasoning (0.022, 95% CI: 0.007 to 0.038) and verbal fluency (0.021, 95% CI: 0.002 to 0.040), but not for short-term memory (-0.003, 95% CI: -0.029 to 0.022). The associations were stronger among women. To conclude, in this longitudinal study, higher residential surrounding greenness was associated with slower cognitive decline.

## **O02.04.07. Area-Level Urban Green Space and Suicide Mortality in Hong Kong**

William Goggins

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**Abstract:** Background: Previous studies have found positive associations between urban green space and better physical and mental health. In addition many ecological studies have found that greater residential area green space was associated with lower mortality rates, although some of these studies found no significant associations between green space and mortality. Methods: We obtained data on all suicide deaths in Hong Kong from 2008 through 2014 classified by 5-year age group, gender, and small area of residence. Mean normalized difference vegetation index (NDVI), and indicator of greenery, was estimated for all small areas for the year 2011 from a satellite image. Negative binomial regression with logarithm transformed suicide counts as the outcome and age group, gender, NDVI, and area-level socioeconomic indicators as predictors, with person-years as the offset term. Results: An increase in area level NDVI from the 25th to 75th percentile was non-significantly associated with a relative risk of suicide mortality = 0.91 (95% confidence interval = 0.81, 1.03) after controlling for age, gender, and small area level socioeconomic status variables. Lower area level education levels and higher percentage never married individuals, but not median household income, were significantly associated with higher suicide mortality rates. Conclusions: Higher area level green space may be associated with lower suicide mortality rates but further studies are needed to confirm this association.

## **O02.04.08. The Association between Medium- and High-Resolution Residential Greenspace Measures and Respiratory Health in Children from an Urban Environment**

J. Michael Wright

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**Abstract:** Previous epidemiological studies of greenspace (GS) and respiratory health studies have not compared GS measures of varying resolution; nor have they examined lung function measures. We examined medium- and high-resolution residential GS measures and respiratory endpoints among 378 participants in the longitudinal Cincinnati Childhood Allergy and Air Pollution Study. We estimated residential GS exposure for participant addresses based on 400 meter (m) radial buffers using Normalized Differential Vegetation Index (NDVI) at a 30 m resolution and Urban Tree Canopy (UTC), including separate tree and grass coverage measures, at 1.5-2.5 m resolution. Associations between GS and asthma and lung function tests at age 7 were examined using linear and logistic regression adjusted for individual- and neighborhood-level confounders. We examined 100 and 800 m NDVI buffer sizes and a 6 months of age exposure window. Although not always statistically significant, we saw improved lung function per each 10% increase in overall UTC coverage. For example, a 4% increase was noted for forced expiratory flow at 25-75%, while 2% increases were seen for forced vital capacity and forced expiratory volume in the first second. Associations similar in magnitude were detected for NDVI. We also detected a decreased risk for asthma based on NDVI data for both 7 years (adjusted odds ratio (aOR)=0.82; 95%CI: 0.59-1.12) and 6 months of age (aOR=0.85; 95%CI=0.53-1.34). Few discernible patterns emerged across different buffer sizes for NDVI or UTC measures, although the strongest association with asthma was found for the 800m buffer at 6 months of age (aOR=0.60; 95%CI: 0.38-0.95). Although we saw little evidence of differences between medium- and high-resolution measures, GS was generally associated with improved childhood respiratory health. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

## **002.04.09. Perceived Stress and Sleep Quality in an Urban Population: The Potential Role of Neighborhood Greenspace**

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**Abstract:** Background: Greenspace has been associated with both perceived stress and sleep quality in the literature. However, few studies have investigated the potential modifying role of neighborhood greenspace on the adverse effect of perceived stress on sleep quality in urban residential populations. Methods: A face-to-face survey was conducted during May to August 2017. We successfully interviewed 614 Chinese adults aged 20 years or above who had lived in Hong Kong in past two years. They completed a 20-minute questionnaire with the items of Sleep Quality Index (SQI), Perceived Stress Scale (PSS), and International Physical Activity Questionnaires (IPAQ). Normalized Difference Vegetation Index (NDVI) near their residential addresses were extracted for each participant to represent the individual neighborhood greenspace coverage. Multinomial logistic regression models were applied to SQI (=1 as good sleep quality, 2-8 as moderate and 9-16 as poor). The variables that reached statistical significance ( $p < 0.05$ ) in univariate logistic regression were included in multivariate logistic regression model, with PSS, NDVI and their interaction term included as predictors. Results: The participants had a mean age of 47.5 years (range 20-99yrs). Of them, 64.1% were women, 59.9% married, 79.4% living with family members (range 1-9 persons) and 80.5% received secondary education or above, . After adjustment for demographic, socioeconomic and lifestyle covariates, perceived stress was a significant predictor on sleep quality (Adjusted odds ratio=1.06 and 1.16, for moderate difficulty and poor sleeper versus good sleep quality, respectively). Interaction term between perceived stress and greenspace coverage was significant. When greenspace coverage increased, the adverse effect of perceived stress on sleep quality decreased. Conclusion: Higher neighborhood greenspace coverage could alleviate the adverse effect of perceived stress on sleep quality in an urban residential population.

## **002.04.10. Greenness and Depressive Symptoms: Air Pollution, Physical Activity, Walking and BMI as Mediators**

Hyeonjin Song

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**Abstract: Background/Aim** Several mechanisms have been suggested for the association between greenness and mental health. The objective of this study is to examine mediating effect of air pollution, physical activity, walking and BMI on the relationship between residential greenness and depressive symptoms. **Methods** This study was based on Korean Community Health Survey 2009 with individuals of general adults in the seven major cities of Korea (N=64,127). Individuals with Center for Epidemiological Studies Depression (CES-D) score  $\geq 16$  were classified as having depressive symptoms. District-level of annual greenness was measured through Normalized Difference Vegetation Index (NDVI) and annual concentrations of PM10 were obtained. **Results** In the regression analysis, controlling for potential confounders, the odds ratio of having depressive symptoms was 0.812 (95%CI: 0.776, 0.849) with an interquartile range (17.61) increase of NDVI. When additionally adjusted for walking (more than or equal to 5 days a week and more than 30 minutes per day) or concentration of PM10, the parameter estimate for NDVI changed about 5.9% and 3.4%, respectively. For physical activity and BMI, the results did not change. **Conclusions** Our findings suggest protective impact of urban greenness on depressive symptoms. The evidence for mediating effect of walking and air pollution was meager for individuals in South Korea. Unknown pathways may explain the impact of greenness besides walking and mitigation of air pollution. This study suggests that exposure to greenness could have positive impact on mental health.

## 002.04C. Indicators of Cumulative Risks

### **002.04.11. Effects of Climate Change on Co-Occurrences of Allergenic Pollen and Photochemical Air Pollutants in the United States**

Ting Cai

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**Abstract:** Ambient air quality has been substantially impacted by climate change over the past few decades. In fact, climate change critically affects both the atmospheric processes involved in the dynamics of air pollution systems and the dynamics of biogenic emissions including trees and grass pollens and fungal spores. Furthermore, the prevalence of Allergic Airway Disease (AAD) is growing globally, resulting in increased numbers of emergency department visits and hospitalizations. Clinical studies show that AAD can be exacerbated by the synergistic action of aeroallergens such as pollen and spores, and atmospheric pollutants such as ozone. Previous studies, involving data from nationwide observations of airborne pollen counts of selected plant species in conjunction with climatic factors, indicated that the start date and length of pollen season, the average peak value and the annual total of daily airborne pollen counts have been affected by the changing climate. The present study investigates co-occurrences of ozone exceedance and allergenic pollens across the contiguous United States (ConUS). Analyses of observed pollen counts and ozone concentrations at 58 pollen monitor stations were conducted. Also, emissions and concentrations of pollens in base years (2004) and future years (2047) were simulated with a customized version of CMAQ (the Community Multiscale Air Quality model) employing a grid with 36 km by 36 km horizontal resolution, while corresponding ozone concentrations at the same resolution for the above timeframes were conducted by a multi-university/agency consortium including USEPA. This study employed spatiotemporal correlation analysis to examine patterns of co-occurring ozone and pollen concentrations; the outcomes of this analysis provide information that can support development of strategies for managing health-impacts of co-occurring photochemical pollutants and aeroallergens.

## **O02.04.12. Association between Multiple Environmental Factors with Neurological Diseases in Metro Vancouver, British Columbia, Canada**

Weiran Yuchi

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**Abstract:** Background: Limited evidence suggests the potential for associations between air pollution with neurodegenerative disorders such as Multiple Sclerosis (MS), Parkinson's Disease (PD) and dementia. Further, other environmental factors such as noise and green spaces have yet to be examined. Objectives: We aim to assess the effects of spatially co-varying environmental exposures - noise, nitrogen dioxide (NO<sub>2</sub>), fine particulate matter (PM<sub>2.5</sub>) and green space - on the incidence of MS, PD and dementia in the Vancouver, British Columbia (BC), Canada metropolitan region. Here we present initial analyses for MS. Methods: Cases and age- and sex-matched controls were identified in a population-based (N = 674,176) cohort of adults derived from health insurance records. Incident cases from 1999 to 2002 were identified by relevant diagnostic codes and pharmaceutical dispensation data. Environmental exposures were assigned to each study subject based on their residential postal codes, accounting for changes in residence. We applied conditional logistic regression to estimate the increased odds of developing MS, PD and dementia in relation to an interquartile range increase in exposures, while adjusting for neighborhood level median income level. Results: Compared to their matched controls, MS cases (N = 289) were increased by 21% (95% CI: 0.79, 1.86) in relation to noise exposure, and by 11% (95% CI: 0.79, 1.55) and 7% (95% CI: 0.76, 1.52) for NO<sub>2</sub> and PM<sub>2.5</sub> respectively. A change in neighborhood green space was associated with a 38% decrease in the odds of a MS case (OR= 0.62, 95% CI: 0.38, 0.98). Conclusions: Noise and air pollution exposure may increase the risk of MS incidence while neighborhood green space had a protective effect.

### **002.04.13. A Novel Distributed Approach to Characterize Community Characteristics and Environmental Exposures in the Multi-Site Children's Respiratory and Environmental Workgroup (CREW)**

Patrick Ryan

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**Abstract:** Background: Assessing community and environmental exposures based on location is a significant challenge in multi-site studies due to restrictions in sharing private health information. Our objective was to develop a reproducible and distributed method to derive community characteristics, including measures of disparities, for the Children's Respiratory and Environmental Workgroup (CREW), a multi-site consortium of birth cohorts participating in the NIH ECHO program. Methods: We used a software containerization platform to enable individual sites to geocode their participants' birth record addresses and link these to community characteristics. Census tract-level information regarding race, ethnicity, education, housing, and other indicators of disadvantage was obtained from the decennial U.S. census in 1990, 2000, and 2010. These data, combined with a TIGER/Line address range geocoder, census tract boundaries, and analysis code were containerized and distributed to individual CREW sites. Each site utilized the software to assign tract-level information to participants' birth addresses, removed identifiers, and returned the data to a central site for analysis. Results: Birth addresses for 6,504 children enrolled in eight cohorts were linked to tract-level information using our containerized software. Collectively, the mean percentage of households below the poverty level in participants' census tracts was 15%; this varied across cohorts from 5% to 28%. The overall mean and range of census tract percentage of white population, single parent households, and unemployed adults was 67% (23-93%), 22% (12-39%), and 10% (5-16%), respectively. Conclusion: The custom software designed for CREW allowed the consortium to derive community characteristics across cohorts while maintaining participant confidentiality and HIPAA compliance. The approach will be expanded to address histories acquired longitudinally and to derive and analyze additional environmental exposures.

## **O02.04.14. The Development of a Cumulative Stressors and Resiliency Index (CSRI) to Examine Environmental Health Risk: A South Carolina Assessment**

Kristen Naney

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Abstract: Several South Carolina (SC) communities are overburdened by pollution and may suffer from environmental health disparities. They may also lack access to resiliency buffers (community assets) that can counteract negative environmental exposures. To effectively address this double disparity, improvements in screening approaches and cumulative risk assessment (CRA) methods are needed to better understand and mitigate risk. The purpose of this study was to develop a cumulative stressors and resiliency index (CSRI) to rank human health and environmental risks at the census tract level in SC. We performed Principal Component Analysis (PCA) on variable subcategories to reduce the proposed indicators to 20 that reflected environmental stress and resiliency in communities impacted by environmental injustice. CSRI scores (0 - 100) were computed at the census tract level and high-risk (HR) census tracts were identified as CSRI scores in the 90th percentile. We performed a one-way analysis of variance (ANOVA) on CSRI scores by Environmental Affairs (EA) region and linear regression for percent non-white and CSRI scores. Choropleth maps were developed in ArcMap 10.5 using natural breaks to visualize spatial relationships. CSRI scores ranged from 7.4 - 64.0. The mean CSRI score for SC was 29.1, which was lower than the mean score for Upstate (35.2) and Midlands (31.7) regions. The one-way ANOVA results indicated a statistically significant difference in CSRI scores by EA region ( $p < 0.0001$ ) except between the Lowcountry and Pee Dee regions [95% CI: -1.53, 2.68]. Based on the regression results, a one-unit increase in the percentage of non-white populations per census tract increased CSRI scores by roughly 6.1%. The results of our study provide a blueprint for targeting low resiliency communities for public health interventions and supports the inclusion of resilience factors in environmental justice (EJ) assessments.

## **O02.04.15. Cumulative Risk and Impacts Modeling on Environmental/Chemical and Social Stressors**

Aolin Wang

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**Abstract:** Background: A growing literature has emerged in recent years that evaluates combined health effects of environmental exposures and social stressors. To identify and incorporate the potential impacts of such joint exposures is critical in cumulative risk assessment and impact studies, but creates analytical challenges. A review of cumulative risk and impacts modeling techniques on environmental/chemical and social stressors can provide useful modeling reference for the progression of future cumulative risk and impact studies. Methods: We conducted a review to identify the types of statistical models utilized in cumulative risk and impact modeling in environmental health studies. The specific review question was: What are the existing quantitative methods used to examine the cumulative impacts of exposures to both environmental/chemical and social stressors on health? We conducted a systematic search over the period of 1 January 2012 through 21 June 2017 to identify original peer-reviewed research articles that evaluate both environmental and social stressors and analyzed their health effects. We focused on human subject studies where information regarding quantitative method used was reported. Results: Among the 376 articles found, we identified 31 eligible articles of which the majority used simple regression models. Multilevel/hierarchical models, generalized linear regression models, and some unsupervised methods were also utilized in some previous studies. Air pollutants and socioeconomic factors, especially race/ethnicity and income level, were among the most frequently evaluated chemical and non-chemical stressors. Mortality rate, cancer risk, and adverse pregnancy outcomes were the most frequently evaluated health effects. Conclusions: With appropriate study design and modeling assumptions, we recommend that additional data mining methods may be useful to better characterize combined effects of environmental and social stressors for risk assessment.

## O02.04D. Integration of Chemical Transport and Dispersion Models to Improve Spatiotemporal Air Pollution Estimates

### **O02.04.16. Combining Satellite Imagery and Numerical Model Simulation Results to Estimate Daily Ambient Air Pollution: An Ensemble Averaging Approach**

Howard Chang

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**Abstract:** Background: Ambient fine particulate matter less than 2.5  $\mu\text{m}$  in aerodynamic diameter (PM<sub>2.5</sub>) has been linked to various adverse health outcomes. However, the sparsity of air quality monitors greatly restricts the spatio-temporal coverage of PM<sub>2.5</sub> measurements and limits the accuracy of PM<sub>2.5</sub>-related health studies. Methods: We develop a method to combine estimates from two current data integration approaches for PM<sub>2.5</sub> using satellite-retrieved aerosol optical depth (AOD) and simulations from the Community Multi-scale Air Quality (CMAQ) modeling system. Previous methods utilize either AOD or CMAQ separately or use a multi-stage approach where prediction error is difficult to quantify. We aim to leverage advantages offered by both methods in a unified modeling framework. Borrowing from weather forecasting techniques, we adapt Bayesian ensemble averaging to statistical downscaler models. The cross-validated predictive performance for AOD and CMAQ at a single monitor determines the spatially varying averaging weights, which are then extended to a full spatial region using kriging. Results: Analysis of 63 monitoring locations in the southeastern United States from 2003 to 2005 indicates good predictive performance of 1 km AOD and 12 km CMAQ downscalers individually with R<sup>2</sup> values of 0.78 and 0.81 in 10-fold cross-validation experiments; the ensemble averaging approach increased overall R<sup>2</sup> up to 0.83. This approach also shows that the usefulness of AOD and CMAQ differs spatially, as evidenced by estimated averaging weights varying from approximately 0.3 to 0.9 for CMAQ. Conclusion: The ensemble framework can be used to improve exposure assessment and subsequently inform health effect estimation and health impact analyses; it also provides prediction intervals, which are often not available from previous methods. The approach herein is highly applicable for estimating other environmental risks, such as ambient temperature and heavy precipitation.

## **O02.04.17. A Hybrid Modeling Framework to Estimate Traffic-Related Exposure in Three Connecticut Cities**

Kristina Wagstrom

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**Abstract:** Traffic-related air pollution is one of the major challenges facing urban areas. As traffic-related emissions result in air pollutant concentrations that vary over spatial scales of under 100m, it is challenging to implement models to capture this behavior. In this study, we develop a hybrid modeling framework combining a regional model (CAMx) and a local scale dispersion model (RLINE) to estimate concentrations of both primary and secondary species from roadway emission sources. We use the Particulate Matter Source Apportionment Technology (PSAT) to quantify the concentrations from traffic-related emission sources. We employ RLINE to estimate pollutant distribution profiles for traffic-related emissions for typical diurnal conditions each month at a fine resolution. We use the traffic-related contributions from CAMx-PSAT alongside the profiles from RLINE to distribute the traffic-related contributions spatially and temporally. This allows us to efficiently estimate air pollutant concentrations at fine spatial (40mx40m) and hourly temporal resolution. We conduct a model evaluation of our framework for NO<sub>2</sub> in the year 2011 using both satellite data and regression model estimates at census block resolution. We have applied this modeling framework to three cities in Connecticut (Hartford, New Haven, and Windham) and quantified human exposure to NO<sub>x</sub>, PM<sub>2.5</sub>, and elemental carbon. We also assess the health risk associated with each species for individuals of different age and genders. Finally, we quantify the environmental inequality based on income and population density. Our approach using a dispersion model is unique as it uses the mass fraction of the total dispersed pollutant at different receptor points and hence is not dependent on extensive roadway emissions data or extensive model runs. This modeling approach overcomes two major challenges facing modeling for traffic-related exposures: double counting emissions and a lack of temporal variability.

## **O02.04.18. Modelling the Intra-Urban Variability of NO<sub>2</sub> for Estimating Human Exposure in Guangzhou, China**

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Abstract: NO<sub>2</sub> concentrations within cities are known to have high spatio-temporal variation and estimating intra-urban variability of NO<sub>2</sub> accurately is important for human exposure assessments. Land-use regression (LUR) and dispersion models (DM) are widely used for estimating air pollution exposure. Few models have been developed in China on this scale due to scarcity of input data, especially from monitoring data. Integration of LUR with DM can help to overcome the lack of data. The aim of this study is to use both LUR and DM, including in combination, to simulate NO<sub>2</sub> concentrations for the city of Guangzhou and to explore the differences between modelled results. NO<sub>2</sub> observations at 10 sites are obtained from <http://beijingair.sinaapp.com> for 2017. Hourly concentrations are averaged to annual mean values. DM with ADMS-Urban is applied in Guangzhou using input data including emissions from Multi-resolution Emission Inventory for China (MEIC), road geometry from OpenStreetMap, and hourly meteorological data from the National Oceanic and Atmospheric Administration (NOAA). The results are validated using NO<sub>2</sub> observation, which are also used to develop a LUR model. Using a geographic information system, spatially explicit predictor variables in different buffer zones are regressed against monitoring data. The predictor variables include road networks, land-use classification, and population density. A stepwise multiple regression approach is used with a priori-defined predictor variables. These predictor variables are selected to maximize the adjusted percentage explained variance (R<sup>2</sup>). Model performance is evaluated by leave-one-out cross-validation. In the integrated model, DM generated concentrations of NO<sub>2</sub> at various receptors are used to develop LUR models. Modelled concentrations of the three approaches are compared with the aim to determine the best approach to derive urban pollution maps of NO<sub>2</sub> over the city to assess population exposure.

## **O02.04.19. Brown Coal Mine Fire-Related Fine Particulate Matter and Medical Service Utilisation in Australia: A Time Series Analysis**

Yuming Guo

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**Abstract:** Background: There is a knowledge gap as to whether coal mine fire smoke has adverse health risks. This study aimed to assess the association between coal mine fire-related PM<sub>2.5</sub> and health service utilisation across five localities in South-eastern Victoria, Australia after wildfires ignited a coal mine fire which burned for six weeks in 2014. Areas in the immediate vicinity of the mine were estimated to experience hourly mine fire-related PM<sub>2.5</sub> concentrations of up to 3700 µg/m<sup>3</sup>. Methods: Data on medical service utilization between 2012 and 2016 were collected from the Medicare Benefits Schedule; a national database of use of medical services. Spatially resolved PM<sub>2.5</sub> concentrations were retrospectively modelled using The Air Pollution Model (TAMP), a dispersion model, coupled with a Chemical Transport Model. Poisson distributed lag time series analysis examined the association between daily mine fire-related PM<sub>2.5</sub> concentrations and medical service utilization for respiratory, cardiovascular and mental health conditions. Confounders included seasonality, long-term trend, day of the week, maximum ambient temperature and public holidays. Results: Positive associations were found between mine fire-related PM<sub>2.5</sub> and all medical service types, after lag 2-5 days. A 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> was associated with a 19% (95%CI 16-22%) increase in the risk of long and short General Practice consultations, 29% (17-42%) increase in cardiovascular services, 27% (10-46%) increase in respiratory services and 13% (4-22%) increase in mental health consultations. Conclusions: Coal mine fire-related PM<sub>2.5</sub> exposure was associated with increased use of medical services for respiratory, cardiovascular and mental health. These findings can inform the development of future public health policy responses in the event of major air pollution episodes.

## **002.04.20. Estimating Exposure to Air Pollution for Long and Short Term Health Effects Using Coupled Regional and Local Scale Dispersion Models - CMAQ-Urban**

Sean Beevers

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**Abstract:** Background: Recent developments in coupling regional and local scale dispersion models enable address level estimates of exposure to be made each day over many years, and from city streets to continental scales. These models can be used to estimate both long and short term health effects for a range of pollutants including: PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>X</sub>, NO<sub>2</sub> and O<sub>3</sub>, as well as PM components. Methods: As part of the UK Medical Research Council funded, Comparative evaluation of Spatio-Temporal Exposure Assessment Methods for estimating the health effects of air pollution (STEAM) project, we have used the Eulerian Community Multiscale Air Quality model (CMAQ), coupled to the local scale Atmospheric Dispersion Modelling System (ADMS) roads model. We will present the novel modelling approaches and methods used to create the coupled model, demonstrating its use at city to continental scales. Results: Using the model, we have predicted hourly and daily air pollution concentrations for 5 years at 20m spatial resolution over London, as well as annual average concentrations at 20m scale across Europe. Comparison with fixed site measurements (from kerbside to rural) across London show that the model performs well, having daily r values of 0.86 (NO<sub>X</sub> and NO<sub>2</sub>), 0.79 (O<sub>3</sub> 8hr), 0.67 (PM<sub>10</sub>) and 0.94 (PM<sub>2.5</sub>) and a normalised mean gross error of 0.28 (NO<sub>X</sub>), 0.25 (NO<sub>2</sub>), 0.24 (O<sub>3</sub> 8hr), 0.2 (PM<sub>10</sub>) and 0.17 (PM<sub>2.5</sub>). Conclusions and future work: The coupling of regional and local scale models provides an efficient solution to air pollution predictions at all of the relevant spatial and temporal scales for public health research. However, a significant limitation of the modelling approach is the development of detailed emissions inventories, especially for road transport. We will also discuss our approach to developing detailed traffic emissions using satellite data, as part of an on going European Space Agency project.

## 002.04E. Prenatal Pesticide Exposure

### 002.04.21. Dietary and Non-Dietary Predictors of Pyrethroid Pesticides in a Cohort of Urban Pregnant Women

Pam Factor-Litvak

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**Abstract:** Pyrethroids and organophosphate pesticides are used in agriculture and residential areas to protect crops and reduce the transmission of insect-borne diseases. We aimed to investigate dietary and non-dietary predictors of pyrethroid and organophosphate urinary concentrations of five biomarkers (3-PBA, PNP, CPM, OPM, and 24-D) among healthy pregnant women aged 16-35 living in New York City. Urinary pesticides biomarkers of 153 women who participated in the Thyroid Disruption and Infant Development Study were measured. We imputed the median) subsequently to assess their association with dietary and non-dietary predictors. Baseline demographic and dietary data were collected from all women at the time of recruitment in prenatal clinics. After excluding cases with missing values on dietary and non-dietary predictors, 137 participants were included in our analysis. Ordinal logistic regression models with dietary and non-dietary predictors were used to predict level of biomarker; in these models odds ratios under 1.0 represent increased odds. The proportional odds assumption held. For each year increase in maternal age, the odds of having higher concentrations of 24-D was higher [OR=0.92 (95%CI: 0.85,0.98)]. Hispanic women had higher odds of having lower concentrations of CPM and OPM [OR=5.0 (95%CI: 1.70,14.73), [OR=3.43 (95%CI: 1.24,9.51)]. Dietary variables predicted the concentration of PAR. Mothers who reported eating any organic products had higher odds of having higher urinary levels of OPM compared to those who did not [OR=0.36 (95%CI: 0.14, 0.94)]. Age and ethnicity predict pyrethroid and organophosphate concentrations in this population of pregnant women. Our intriguing finding of higher concentrations of OPM in mothers who report eating organic products requires confirmation in future work with more detailed dietary assessments.

## **O02.04.22. Effect of a Longitudinal, Randomized Organic Diet Intervention on 2,4-D, Pyrethroid and Organophosphate Pesticide Exposures among Pregnant Women**

Cynthia Curl

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**Abstract:** Background: Several short-term (1-2 week) interventions in children and adults have shown that introduction of a fully "organic" diet can significantly reduce pesticide exposure. Objectives: We assessed the effect of a long-term (6 month) organic diet intervention on pesticide exposure among pregnant women. We supplemented women's existing diets with weekly deliveries of either organic or conventional produce to reflect real-world consumption patterns. We hypothesized that pesticide exposure would be lower in the organic group. Methods: We recruited 20 women in their first trimesters of pregnancy. Eligible women were non-smokers aged 18-35 who reported eating exclusively conventionally-grown food. Participants were randomized to receive weekly deliveries of either organic or conventional produce throughout their second and third trimesters. They completed daily food diaries and provided weekly spot urine samples. Urine samples were pooled to represent monthly exposures and analyzed for eight biomarkers representing exposure to one herbicide, seven organophosphates and eight pyrethroid insecticides. Results: We collected an average of 23 weekly samples per participant, for a total of 461 individual samples. We detected p-nitrophenol (PNP), 2,4-dichlorophenoxyacetic acid (2,4-D,) and 3-phenoxybenzoic acid (3-PBA) in 99%, 90%, and 74% of samples, respectively. Long-term average concentrations of 2,4-D and 3-PBA were significantly lower in women in the organic group compared to the conventional group (2,4-D: 0.36 vs 0.57 µg/L, p=0.05; 3-PBA: 0.70 vs 2.21 µg/L, p=0.02). PNP concentrations were also lower in the organic group, but this difference was not significant (0.54 vs 0.63 µg/L, p = 0.3). Conclusion: This is the first long-term organic diet intervention study and the first to evaluate pregnant women. Concentrations of 2,4-D and 3-PBA were significantly reduced in women whose diets were supplemented with organic produce compared to those receiving conventional produce.

## 002.04.23. Maternal Residential Pesticide Use and Risk of Childhood Leukemia in Costa Rica

Carly Hyland

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Abstract: Evidence suggests that early-life exposure to pesticides inside the home may be associated with childhood leukemia, however data from Latin American countries are limited. We examined whether self-reported maternal residential pesticide use and nearby pesticide applications--before and after child's birth--were associated with acute lymphoblastic leukemia (ALL) in the Costa Rican Childhood Leukemia Study (CRCLS), a population-based case-control study (2001-2003). Cases (n=251 ALL) were diagnosed between 1995 and 2000 (age <15 years at diagnosis) and were identified through the Costa Rican Cancer Registry and National Children's Hospital. Population controls (n=577) were drawn from the National Birth Registry. We fitted unconditional logistic regression models adjusted for child sex, birth year, and socioeconomic status to estimate the exposure-outcome associations and also stratified by child sex. We observed that self-reported maternal insecticide use inside the home in the year before pregnancy, during pregnancy, and while breastfeeding was associated with increased odds of ALL among boys [adjusted Odds Ratio (aOR) = 1.63 (95% Confidence Interval (95% CI)): 1.05-2.53], 1.75 (1.13-2.73), and 1.75 (1.12-2.73), respectively]. We also found evidence of exposure-response relationships between more frequent maternal insecticide use inside the home and increased odds of ALL among boys and girls combined. Maternal report of pesticide applications on farms or companies near the home during pregnancy and at any time period were also associated with ALL. This study in Costa Rica highlights the need for education to minimize pesticide exposures inside and around the home, particularly during pregnancy and breastfeeding.

## 002.04.24. Pyrethroid Metabolites during Pregnancy and Longitudinal Child Behavior in the Cincinnati HOME Study

Melissa Furlong

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**Abstract:** Pyrethroids are the most commonly used residential insecticides in the United States. Although toxicological and cross-sectional studies report overall and sex-specific associations between pyrethroids and behavior in animals and humans, longitudinal epidemiological reports are scarce. We used the Cincinnati HOME Study to examine associations of urinary pyrethroid metabolites (3-PBA, trans-DCCA, 4F-PBA) at 16 and 26 weeks of pregnancy with child behavior measured with the BASC-2 and BRIEF(-P) at 3, 4, 5, and 8 years (n=301). We examined continuous measures of log 3-PBA and creatinine-adjusted 3-PBA quartiles. Since detection frequencies for 4F-PBA and trans-DCCA were <20%, we dichotomized these at the LOD. We used linear mixed effects regression with a random intercept for participant, and fixed effects of maternal education, race, smoking, mother's age, home environment, visit age, creatinine, and fresh fruit and vegetable consumption. We evaluated modification by sex ( $\alpha=0.05$ ). There were no consistent overall associations between any metabolite and behavior. However, 16 (but not 26) week urinary 3-PBA and 4F-PBA concentrations were modified by sex. Dose-response relationships among girls for 3-PBA at 16 weeks were driven by the 4th quartile (Externalizing Composite Q4  $\beta=4.79$ , 95% CI 1.61, 7.96,  $p$  trend=0.04; Aggression Q4  $\beta=3.22$ , 95% CI 0.08, 6.36,  $p$  trend=0.03; Hyperactivity Q4  $\beta=5.16$ , 95% CI 1.93, 8.40,  $p$  trend<0.01; Inhibitory Control Q4  $\beta=4.67$ , 95% CI 0.80, 8.53,  $p$  trend=0.03). Detection of 4F-PBA at 16-weeks was associated with the Behavioral Symptoms Index ( $\beta=3.38$ , 95% CI 0.65, 6.11), Attention ( $\beta=3.40$ , 95% CI 0.70, 6.10), Hyperactivity ( $\beta=3.19$ , 95% CI 0.29, 6.09), and Working Memory ( $\beta=4.74$ , 95% CI 0.79, 8.68) among girls but not boys. Sex interaction p-values were <0.05 for 4F-PBA and both 3-PBA variables in above models. Pyrethroid exposures during early pregnancy may be associated with the development of ADHD-related behaviors during childhood, in girls.

## **002.04.25. Insecticide Exposure and Infant Visual Function**

Monica Silver

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**Abstract:** Introduction: Fetal and infant brains are rapidly developing, yet the neurodevelopmental effects of early-life exposure to many commonly used insecticides are largely unknown. Here we examined the effects of prenatal insecticide exposure on infant grating visual acuity (VA), an important indicator of visual pathway development. Methods: 15 insecticides and acaricides of various classes were measured in umbilical cord blood plasma from a cohort of infants in Fuyang County, China (n=195). Binocular grating VA was measured using the Teller Acuity Card (TAC) preferential looking procedure at 6 weeks, 9 months, and 18 months. Insecticides were analyzed as 3-level ordinal (non-detect [ND]/medium/high), or dichotomous (ND/detect), depending on detection rates. Generalized linear and linear mixed models were used to evaluate relationships between pesticides and VA throughout infancy. Logistic regression was used to explore effects of prenatal exposure on visual impairment (as defined by ICD-10) at 18 m. Results: Propoxur, prothiofos, aldrin, and DDT metabolites, DDE o,p and DDE p,p, were detected in 100, 59.4, 84.2, 32.1, and 10.3% of samples, respectively. Infants prenatally exposed to high propoxur, aldrin, and DDE p,p all had lower VA scores (vs. ND) at the two early time points (6 wks and 9 m). Infants with prenatal exposure to prothiofos had lower VA scores (vs. ND) at all three time points. VA scores were significantly lower at 6 wks;  $\beta$  (95%CI),  $p = -0.19$  (-0.36, -0.03),  $p = 0.02$  and  $-0.09$  (-0.25, 0.07),  $p = 0.28$ , for high and medium prothiofos vs. ND, respectively; overall  $p$ -trend=0.02. Prothiofos-exposed infants also had increased odds of visual impairment at 18 months; OR (95%CI),  $p = 2.79$  (1.21, 6.41), for medium prothiofos vs. ND. Conclusions: Prenatal exposure to the organothiophosphate prothiofos was associated with deficits in infant grating VA. Delayed visual pathway maturation could potentially negatively affect downstream cognition.

## O02.04F. Air Pollution, Cognitive Function, and Mental Health

### O02.04.31. Mental Health Consequences of Air Pollution: Retrospective Population Based Cohort Survey

Ioannis Bakolis

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Abstract: The World Health Organization (WHO) recently estimated that ambient air pollution causes 482,000 premature deaths within the WHO European Region. However, the significant potential health and societal costs of poor mental health in relation to air quality is not represented in the WHO report. This reflects the limited number of studies directly linking air pollution exposure to adverse mental health outcomes published to date. The aim of the study is to address the gaps of existing literature and quantify the effect of medium-term exposure of residential traffic air pollution at address level on common mental and psychiatric disorders as well as on physical health. A longitudinal mental health survey was conducted of 1,698 adults living in 1,075 households in South East London, from 2008 to 2013. High-resolution (20m x 20m) residential address level air pollution metrics were employed with the use of the established King's College London urban dispersion model. Data were analysed with the use of multilevel generalised linear models. Average air pollutant exposures across the time period of the study area were 43 µg/m<sup>3</sup> nitrogen dioxide (NO<sub>2</sub>), 79 µg/m<sup>3</sup> nitrogen oxides (NO<sub>x</sub>), 22 µg/m<sup>3</sup> particulate matter with aerodynamic diameter <2.5 µm (PM<sub>2.5</sub>), 23 µg/m<sup>3</sup> particulate matter with aerodynamic diameter <10 µm (PM<sub>10</sub>), and 32 µg/m<sup>3</sup> ozone (O<sub>3</sub>). We found strong evidence for interquartile range increases in PM<sub>2.5</sub>, NO<sub>2</sub>, NO<sub>x</sub> to be associated with 18% to 38% increased odds of common mental disorders, 18% to 29% increased odds of poor physical health, and 15% to 25% of psychotic experiences based on standardised and validated questionnaires, after adjusting for large number of confounders, including individuals socioeconomic position and urban noise. These longitudinal associations were more pronounced in the subset of non-movers. The findings suggest that air pollution from road traffic in London is adversely affecting mental and psychiatric disorders and physical health.

## **O02.04.32. Triggering of Neurodegenerative Hospital Admissions and Emergency Room Visits by Fine Particle Concentrations in Six Urban Centers in New York State: The New York State Accountability Study**

Edwin van Wijngaarden

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Abstract: Emerging evidence has linked exposure to ambient fine particle (PM<sub>2.5</sub>) concentrations with an increased incidence of neurodegenerative conditions such as dementia, Alzheimer's disease (AD), and Parkinson's disease (PD). Previous studies have not examined the association between ambient PM<sub>2.5</sub> concentrations and exacerbations of symptoms, which would further add to the public health burden of these chronic neurodegenerative conditions. Using the Statewide Planning and Research Cooperative System (SPARCS) database, we retrieved all hospital admissions (inpatient) and emergency room visits (outpatient) with a primary diagnosis of one of three neurodegenerative disease subtypes for NYS residents living within 15 miles from PM<sub>2.5</sub> monitoring sites in Buffalo, Rochester, Albany, Queens, Bronx, and Manhattan from 2005-2016. Using quasi-Poisson regression models adjusting for temperature, relative humidity, and secular trends in hospitalization rates, we examined the association between daily inpatient and outpatient neurodegenerative hospitalizations and ambient PM<sub>2.5</sub> concentrations estimated for short-term and long-term time windows: concurrent exposure as well as lagged by 14, 30, 180, and 365 days. A total of 63,287 inpatient admissions and 14,288 outpatient visits for the three neurodegenerative conditions occurred during the study period. Interquartile range (IQR) increases in PM<sub>2.5</sub> concentration were not associated with increased rates of inpatient AD and dementia hospitalizations. However, increased rates of PD hospital admissions were associated with increased PM<sub>2.5</sub> concentrations in the previous 14 days (rate ratio (RR) = 1.04; 95% confidence interval (CI) = 1.00-1.09), and 30 days (RR=1.06; 95% CI=1.00-1.12). For outpatient visits, an increased rate of AD was associated with increased PM<sub>2.5</sub> in the past 365 days (RR=1.77; 95% CI = 1.03-3.03). Thus, ambient PM<sub>2.5</sub> exposure may be associated with exacerbations of symptoms among patients with neurodegenerative disease.

## **002.04.34. Particulate Air Pollutants and Trajectories of Depressive Symptoms in Older Women**

Andrew Petkus

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**Abstract:** Depressive symptoms in older adulthood are common, costly, and disabling. Airborne particulate matter with aerodynamic diameter of < 2.5  $\mu\text{m}$  (PM<sub>2.5</sub>) is an environmental source of neuroinflammation and oxidative stress, which may increase depressive symptoms in later life. Previous studies examining this association however, report mixed results. We examined the association between PM<sub>2.5</sub> and longitudinal trajectories of depressive symptoms in a geographically-diverse sample of 1,987 older women (aged 74.5 $\pm$  3.70) without prior depression from the Women's Health Initiative Study of Cognitive Aging. Participants completed up to eight annual assessments of depressive symptoms as measured by the 15-item Geriatric Depression Scale. The Bayesian Maximum Entropy method was used to construct spatiotemporal models to estimate time-varying exposure to ambient PM<sub>2.5</sub> at residential locations over the prior three-years of each assessment. Latent-class mixed models (LCMMs) with latent process score transformation was used to cluster individuals with similar trajectories of symptoms. Each model examined the class-specific main effect of PM<sub>2.5</sub> on depressive symptoms adjusting for socio-demographic factors (age, geographical region, employment status, and race/ethnicity), lifestyles (alcohol use, smoking, exercise), and physical health (diabetes, hypertension, cardiovascular disease, and past hormone use). We identified three clusters of participants: A minimal-depressive symptom group (N=718; 36.1%), an emerging-depressive symptom group (N=290; 14.6%), and a sustained-depressive symptom group (N=979; 49.3%). There were statistically significant class-specific main effects of PM<sub>2.5</sub> with higher exposure associated with more depressive symptoms in the sustained group (Beta<sub>PM<sub>2.5</sub> sustained</sub> = .03; p = .036). These findings suggest that PM<sub>2.5</sub> may increase depressive symptoms among older women with no prior depression and manifested with mild but sustained depressive symptoms in late life.

## **O02.04.35. The Association between Air Pollution and Depression: Evidence from the Ginkgo Evaluation of Memory Study**

Anjum Hajat

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**Abstract:** Introduction: Depression is one of the leading causes of morbidity globally. Thus identifying modifiable risk factors for depression is urgently needed. There is growing evidence that air pollution impacts the brain and has been associated with depression and other mental health outcomes. We evaluated the association between several criteria air pollutants and prevalent depression in a cohort of older adults. Methods: The Ginkgo Evaluation of Memory Study (GEMS) is a rich longitudinal cohort of older adults (age 75 and older) recruited from four sites across the US. Depression was measured using the 10 item Centers for Epidemiologic Studies - Depression (CES-D) scale (scores ranged between 0 and 26) approximately every six months for a nine year follow up period. Fine particulate matter (PM<sub>2.5</sub>), coarse particles (PM<sub>10</sub>) and nitrogen dioxide (NO<sub>2</sub>) were predicted from a national universal kriging model which estimated annual average pollutant levels at participant's residential address one to two years prior to enrollment. We modelled depression as a continuous outcome and used linear regression models adjusted for socio-demographic factors, health behaviors and co-morbidities. Results: Preliminary results suggest an interquartile range (IQR) higher level of PM<sub>2.5</sub> (2 µg/m<sup>3</sup>) was associated with 0.2 unit higher score on the CES-D scale (95% confidence interval (CI): 0.06, 0.33). Similar results were seen for PM<sub>10</sub>. An IQR higher NO<sub>2</sub> level (7 ppb) was associated with 0.27 higher score on the CES-D (95% CI: 0.04, 0.50). Additional analyses will evaluate the onset of depression among this population. Conclusions: Although our observed associations are small in magnitude, our study contributes to the existing evidence of a positive association between air pollution and depression. Our study uses a well validated depression measure, robust air pollution predictions and a rich longitudinal cohort of older adults.

## **O02.04.36. Association of Air Pollution with Depressive Symptoms in the Elderly and Effect Modification by Cognitive Performance**

Tamara Schikowski

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**Abstract:** Background: Research regarding the effects of air pollution on depressive symptoms are limited and results are conflicting. Objective: Associations between long-term air pollution exposure and depressive symptoms in the elderly were assessed and whether mild cognitive impairment (MCI) modifies the association of air pollution with depression. Methods: We included 777 elderly women from the SALIA study (age 66-79). Self-reported depressive symptoms were evaluated by the CES-D test score  $\geq 16$  as a dichotomous outcome. Cognitive performance was assessed by the CERAD-Plus test battery. Air pollutant concentrations were assigned to home addresses by ESCAPE land-use regression models. We also estimated road traffic noise exposure as 24h-mean at facade points. Our adjusted logistic regression models included age, body mass index, smoking habit, environmental tobacco exposure at home, educational level, urban/rural living, physical activity, cardiovascular disease, respiratory diseases, diabetes and the CERAD score as covariates. Results: The prevalence of depressive symptoms and MCI were 15.7% and 59.8%, respectively. In pooled sample, we observed significant associations between an interquartile range (IQR) increase of PM<sub>10</sub> (OR= 1.37; 95%CI: 1.07-1.76), PM<sub>2.5</sub> (OR= 1.74; 95%CI: 1.20-2.53), NO<sub>2</sub> (OR= 1.43; 95%CI: 1.04-1.94) and NO<sub>x</sub> (OR= 1.58; 95%CI: 1.14-2.17) with the presence of depressive symptoms. Women with MCI had more air pollution-induced depressive symptoms: PM<sub>10</sub> [OR =1.51 (95% CI: 1.10, 2.07) pint= 0.074], PM<sub>2.5</sub> [OR =1.91 (95% CI: 1.20, 3.05) pint=0.073], NO<sub>2</sub> [OR =1.73 (95% CI: 1.38, 2.64) pint=0.020] and NO<sub>x</sub> [OR =1.78 (95% CI: 1.17, 2.71) pint=0.009]. We found no associations for women without MCI. No associations were found for coarse fraction of PM, PM<sub>2.5</sub> absorbance and noise exposure. Conclusions: Air pollution might affect depressive mood and elderly with MCI might be more prone to develop depression when additionally exposed to air pollution.

## S02.04A. Children's Exposure to SVOC Mixtures in the Home Environment

### S02.04.01. Associations between Placental Brominated Flame Retardant Levels and Birth Outcomes in a NC Cohort

Heather Stapleton

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**Abstract:** Brominated flame retardants (BFRs) are ubiquitous, persistent contaminants that accumulate in human tissues and pass from mother to fetus through the placenta. One class of BFRs, polybrominated diphenyl ethers (PBDEs), has a chemical structure that is very similar to endogenous thyroid hormones (THs), and numerous laboratory studies have demonstrated that PBDEs can interfere with thyroid hormone regulation through a variety of different mechanisms. Studies suggest possible relationships between maternal serum BFRs and fetal development, but results have been inconsistent. To evaluate relationships between BFRs concentrations measured in placenta, a potentially more biologically relevant measure of exposure and birth outcomes, we analyzed samples from pregnant women (n=102) from Durham, NC. Women provided serum and placenta samples which were analyzed for BFRs and birth outcome data was abstracted from medical records. In this cohort we found that BFRs, including PBDEs, accumulated to significantly higher levels in placenta associated with male infants compared to female infants, despite no differences in maternal serum levels by fetal sex. We also found that TH levels in human placental tissues were associated with placenta BFRs in a sex-specific manner. We statistically evaluated associations between BFRs (serum and placenta) and continuous measures of birthweight and gestational age while adjusting for relevant covariates. Placenta BFRs were associated with lower birthweight and shorter gestation, particularly among female infants. Baby girls with the highest BDE-153 exposures, for example, were born 1.5 weeks earlier (95% confidence interval: -2.6, -0.3) than those with low levels of BDE-153 in placenta. Associations between serum BFRs and birth outcomes followed similar patterns but were generally weaker. This research has significant implications for understanding the full impact of contaminant exposures on placenta function and fetal development.

## **S02.04.02. Biomarkers of Exposure to Semi-Volatile Organic Compounds (SVOC) among Pregnant Women in Puerto Rico**

John Meeker

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Abstract: There is some evidence for widespread environmental contamination in Puerto Rico, as well as increased rates of adverse pregnancy outcomes and child developmental disorders, yet human studies of human exposure on the island are lacking. To better characterize exposure distributions, temporal variability, and predictors of exposure among pregnant women on the island, to date we have collected urine and serum samples from over 1,200 pregnant women as part of the Puerto Rico Testsite for Environmental Contamination Threats (PROTECT) cohort study. Samples are collected at study visits occurring at 18±2, 22±2, and 26±2 weeks gestation, along with extensive questionnaire data. Urinary or serum concentrations of biomarkers of exposure related to a range of SVOCs (including phthalates, phenols, PAH, brominated and phosphorus-containing flame retardants, pesticides, per- and polyfluoroalkyl substances [PFAS], and others) were measured using state-of-the-art analytical chemistry techniques. We found that concentrations of a number of chemicals (e.g., certain phthalates, phenols and PAH) were significantly greater than those among women of reproductive age in the US NHANES study, while others (e.g., PFAS, polybrominated diphenyl ethers [PBDE], polychlorinated biphenyls [PCB], organochlorine pesticides) were lower. Our analysis of predictors (e.g., demographics, housing characteristics, product use) of these biomarker concentrations have revealed a number of significant findings, which may help inform strategies to reduce exposure. We utilized repeated measures of some biomarkers to calculate intraclass correlation coefficients, which can inform future epidemiology studies and exposure assessments. Finally, we explored the degree to which co-exposures to these chemicals, both within and between chemical groups, was present. Future goals of the study include investigating associations between exposure to chemical mixtures and adverse birth and child development outcomes.

### **S02.04.03. PFAS Serum Concentrations in Pregnant Women from North Carolina: Predictors and Associations with Birth Weight and Gestational Age at Birth**

Jessica Craig

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Abstract: Per- and polyfluoroalkyl substances (PFAS) are commonly found in consumer products, exposure is ubiquitous. We examined associations between maternal serum concentrations of six PFAS during pregnancy and birth outcomes in 130 mother-child pairs from the North Carolina-based TESIE Study (2009-2011). We used multivariable and weighted quantile sum (WQS) regression models to estimate total and sex-specific associations between birth outcomes and individual and cumulative exposure to maternal serum PFAS concentrations, respectively. Among male offspring, linear and branched perfluorooctane sulfonic acid (n-PFOS and Sm-PFOS, respectively), linear perfluorooctanoic acid (n-PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) were inversely associated with birth weight and n-PFOS, n-PFOA, Sm-PFOS, and PFNA were inversely associated with gestational age at birth. Among female offspring, only n-PFOA was inversely associated with birth weight, and n-PFOS, n-PFOA, and perfluorodecanoic acid were inversely associated with gestational age at birth. Cumulative prenatal exposure to the six PFAS was inversely associated with birth weight and gestational age at birth [ $\beta = -248.6$ , 95% CI: -454.9, -42.2 grams and  $\beta = -6.3$ , 95% CI: -11.4, -1.3 days, per weighted quartile increase, respectively] among male offspring, with n-PFOA being the most important PFAS for both birth outcomes according to the WQS weights. Among female offspring, cumulative prenatal exposure to PFASs was positively, but imprecisely, associated with birth weight [ $\beta = 76.2$ , 95% CI: -103.3, 255.7 grams per weighted quartile increase] and not associated with gestational age at birth. These results suggest that male offspring may be more susceptible to individual and cumulative prenatal exposure to PFASs than females and that offspring sex is an effect measure modifier of the association between maternal serum PFAS concentration and birth outcomes.

#### **S02.04.04. Using Silicone Wristbands to Assess Children's Exposure to Organophosphate Esters and Brominated Flame Retardants**

Stephanie Hammel

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Abstract: Organophosphate esters (OPEs) are often used as flame retardants and plasticizers and, like brominated flame retardants (BFRs), are frequently detected in indoor environments. Human exposure to semi-volatile organic compounds (SVOCs), including OPEs and BFRs, is widespread, which is particularly concerning for children who often experience higher exposures than adults and are especially vulnerable to long-term negative health impacts. Silicone wristbands have been used as personal passive samplers to examine adult ambient and occupational exposures to a suite of SVOCs and have the potential to be used as a non-invasive and inexpensive method of measuring personal exposures to chemical mixtures. Previously, among adults, OPEs and polybrominated diphenyl ethers (PBDEs, a class of BFRs) on bands have been significantly and positively associated with metabolites in pooled urine samples and serum biomarkers, respectively ( $r_s=0.4-0.7$ ;  $p<0.01$ ). Here, we examine the utility of wristbands for assessing children's exposure to 6 OPEs and several classes of BFRs. Children ages 3-6 and their families were recruited in 2014-16 as part of a study examining children's exposures to SVOCs. Paired passive air samplers, hand wipes, and dust from the home were collected and analyzed; OPEs on hand wipes were significantly correlated with biomarkers from pooled urine samples ( $r_s=0.2-0.4$ ,  $p<0.05$ ). Wristbands ( $n=75$ ) were also deployed among these children and will be analyzed for OPEs and BFRs. Levels on the bands will also be compared to OPE urinary metabolites, which were previously analyzed in our laboratory, and serum PBDEs. Preliminary analyses among wristbands worn by children in a similar age range indicate that OPEs and BFRs are ubiquitously detectable on the bands (GM=2.6-187.5 ng/g). Results from this study will be used to validate wristbands as a tool for assessing personal exposure among children.

## **S02.04.05. Children's Exposure to SVOCs Mixtures: The TESIE Study**

Kate Hoffman

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**Abstract:** Semi-volatile organic compounds (SVOCs) are used in consumer and personal care products and are detected in most indoor environments. As a result, human exposure to SVOCs is widespread. However, data on exposure determinants and patterns of co-exposure have not been thoroughly explored, particularly for young children. We investigated biomarkers of exposure to SVOCs among children age 3-6 years, who may experience higher exposures and be more susceptible to adverse health outcomes than other age groups. Participants were enrolled in the Toddlers Exposure to SVOCs in Indoor Environments (TESIE) study (n=203 children of whom 181 provided urine and 90 provided serum). We quantified 44 biomarkers of exposure to phthalates, organophosphate esters, parabens, phenols, antibacterial agents and per- and polyfluoroalkyl substances. Of these, 29 were detected in >95% of samples and many were detected at higher median concentrations than previously reported in the U.S. general population. Demographic characteristics were associated with concentration differences. Non-Hispanic white race and higher maternal education were generally associated with lower concentrations, even after adjusting for potential confounding variables. Our results suggest that outdoor temperature at the time of biospecimen collection may be a particularly important and under-evaluated predictor of biomarker concentrations; 11 biomarkers were significantly associated with temperature. A complex correlation structure was observed among biomarkers. By and large, statistically significant correlations between biomarkers of phthalates, parabens, phenols, and OPEs were positive. Conversely, although PFASs were positively correlated with one another, they tended to be negatively correlated with other biomarkers where significant associations were observed. Taken together, our results provide evidence that assessments of SVOC-associated health impacts could address chemical mixtures.

## S02.04B. Diving Deep: Mechanisms of Endocrine Disruptors in Pregnancy and Relevant Biomarkers

### **S02.04.06. Longitudinal Associations between Urinary Phthalate Metabolites and Maternal Hormones in the Protect Pregnancy Cohort**

Amber Cathey

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**Abstract:** Phthalates are endocrine disrupting chemicals that may be associated with adverse birth outcomes. Dysregulation of maternal endocrine homeostasis could serve as a mediator between phthalate exposure and adverse birth outcomes. Here we examined associations between maternal exposure to 16 urinary phthalate metabolites and 9 serum hormones measured over two time points during pregnancy (median 18 and 26 weeks gestation). Linear mixed models with random intercepts were used to assess associations between phthalates and hormones. Secondary analyses examined differing effects of phthalate exposure between visits. Triiodothyronine (T3) was significantly associated with all phthalates except mCNP, mEHP, mEP2, MECPTP and MEHHTP. Notably, IQR increases in mECP and mEOHP were associated with an 11.9% increase (95% CI: 6.8, 17.0) and 6.86% increase (95% CI: 3.25, 10.5) in T3, respectively. Corticotropin releasing hormone (CRH) was positively associated with mCPP (% $\Delta$ : 6.93, 95% CI: 2.35, 11.7), mECP (% $\Delta$ : 25.3, 95% CI: 0.72, 55.8), and mEP2 (% $\Delta$ : 32.9, 95% CI: 11.6, 58.2). Significant positive associations were found between numerous phthalate metabolites and free thyroxine (fT4), T4, and the ratio of T3/T4, while an inverse association was found between MEHHTP, a terephthalate metabolite, and progesterone. Testosterone was positively associated with MHBP (% $\Delta$ : 6.07, 95% CI: 1.12, 11.3) and inversely associated with mEP2 (% $\Delta$ : -16.5, 95% CI: -26.8, -4.70). The effects of 8 metabolites on CRH were significantly different between study visits 1 and 3, with associations being consistently positive at visit 1 and negative at visit 3. These results indicate that exposure to phthalates may disrupt the maternal endocrine system during pregnancy, and that timing of exposure may influence the direction of the relationship between phthalate metabolites and maternal hormones.

## **S02.04.07. Association between Exposure to Per- and Polyfluoroalkyl Substances (PFAS) during Pregnancy and Biomarkers of Stress Response in the Maternal-Fetal Unit**

Rachel Morello-Frosch

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Abstract: In a demographically diverse cohort of 500 pregnant women recruited from two San Francisco hospitals, we used linear regression to evaluate the association between eight PFAS with detection frequency of 50% or greater in our sample, and two biological measures of stress response: 1) telomere length (TL) in umbilical cord blood leukocytes collected at delivery, and 2) corticotropin-releasing hormone (CRH) in maternal plasma collected during the 2nd trimester. Both outcomes were log-transformed. PFAS levels (ug/L) were measured in mother's serum during the 2nd trimester, and also log-transformed. Each chemical was assessed separately since levels were highly correlated. CRH analyses were adjusted for pregnancy complications, mother's age, parity, and race/ethnicity. TL analyses were additionally adjusted for infant sex, and gestational age at birth. We also evaluated the associations separately for Latina and White women. The burden of PFAS exposure was greater among Latinas (30% of participants) than White women (40% of participants) in our study population. PFAS were not associated with TL, expressed as the relative ratio of telomere repeat copy number to single-copy gene copy number. A one unit increase in Perfluoroundecanoic acid (PFUDA) was associated with a 0.14 increase in CRH in race adjusted models (95% CI: 0.04-0.23). Higher levels of Perfluorononanoic acid (PFNA; 0.25, 95% CI: 0.07-0.44), Perfluorooctanesulfonic acid (PFOS; 0.161, 95% CI: 0.003-0.32), 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (MePFOSAachOH; 0.18, 95% CI: 0.03-0.34), Perfluorohexane sulfonic acid (PFHxS; 0.20, 95% CI: 0.02-0.38), and PFUDA (0.38, 95% CI: 0.19-0.57) were all significantly associated with higher CRH among Latinas. Higher levels of Perfluorooctanesulfonamide (PFOSA; 0.07, 95% CI: 0.01-0.15) were significantly associated with higher CRH among white women. Results suggest complex relationships between prenatal PFAS exposure and stress response biomarkers.

## **S02.04.08. Inflammation Differentiated from Oxidative Stress in Relation to Environmental Phthalate Exposure: Evidence from Human and Animal Studies**

Kelly Ferguson

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**Abstract:** Exposure to phthalates has been linked to many adverse birth outcomes including preterm birth and preeclampsia. One mechanism behind these associations may be oxidative stress, which is best estimated using biomarkers such as 8-iso-prostaglandin F<sub>2</sub>α(8-iso-PGF<sub>2</sub>α). Previously observed associations with 8-iso-PGF<sub>2</sub>α may be confounded due to simultaneous generation of this marker by an inflammation-driven mechanism. In this study, we reexamined the association between phthalate exposure and elevated oxidative stress using the ratio between 8-iso-PGF<sub>2</sub>α and PGF<sub>2</sub>α, which allows for the quantitative distinction of the two sources of 8-iso-PGF<sub>2</sub>α, i.e., oxidative stress or inflammation, and thus clarifies the true mechanism of the association. We investigated the association between phthalate metabolites and oxidative stress vs. inflammation in the Infant Development and the Environment Study. In 761 urine specimens collected during the 3rd trimester we analyzed phthalate metabolites as well 8-iso-PGF<sub>2</sub>α and PGF<sub>2</sub>α using mass spectrometry. Most phthalates were associated with increased oxidative stress. For example, an interquartile range difference in mono-n-butyl phthalate was associated with a 22% (95% confidence interval=14, 31) increase in the oxidative stress pathway in covariate-adjusted models. Detection of phthalate replacement metabolites such as di(isononyl)cyclohexane-1,2-dicarboxylate (DINCH) was associated with an increase in the inflammation pathway. We also examined these associations in an animal model, in which adult rats were administered di-butyl phthalate (DBP) or di-2-ethylhexyl phthalate (DEHP) and urine samples collected 7 hours after dosing were analyzed by mass spectrometry for the same biomarkers. We observed a similar increase in the oxidative stress pathway in response to DBP exposure. These findings have important implications for developing interventions to prevent adverse birth outcomes when intervening on exposure is difficult or impossible.

## **S02.04.09. Phthalate Exposure and Placental-Fetal Mechanisms of Endocrine Disruption**

Jennifer Adibi

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Abstract: Phthalate exposure in pregnancy is associated with child neurodevelopment and reproductive health. Elucidating the molecular basis for these associations in pregnancy is important 1) to establish causality and 2) to develop strategies to reduce the long-term risks to the health of the child. Our epidemiologic and in vitro experimental work has identified that the placental hormone human chorionic gonadotropin (hCG) is altered by phthalate exposures at the levels of tissue mRNA, intracellular hormone, and secreted hormones. These effects differ by sex of the fetus and by phthalate metabolite. Through collaboration with birth cohort studies, we have moved to a longitudinal framework and identified associations between circulating levels of hCG in early pregnancy and the size of the genitalia at birth and masculinized and feminized play behavior at 2.5 years of age. These endpoints are indicators of fetal sex differentiation. To link the two sets of findings, we applied interaction and mediation analyses, and the 4-way decomposition of these effects to better understand the role of the placenta as a putative modifier vs. a mediator of phthalate toxicity. A review of the literature has revealed that hCG regulates maternal thyroid hormone homeostasis in early pregnancy. Thyroid hormone homeostasis is also hypothesized to be perturbed by phthalates, and may act as a critical mechanistic link between exposure and developmental outcomes. Finally, we will present a pilot analysis of early pregnancy phthalates, placental hCG, and thyroid hormone levels (thyroid stimulating hormone, free thyroxine) in relation to endpoints in the children: birth size, anogenital distance, play behavior at 2.5 years, and infant cognition. Taken together, these findings have the potential to grant insight into molecular fluctuations in early pregnancy that can be measured in real time and used to identify environmental risks to the fetus and the health of the future child.

## **S02.04.10. Bisphenols and Placental Trophoblast Dysfunction**

Almudena Veiga-Lopez

*Almudena Veiga-Lopez<sup>1</sup>*

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Abstract: During pregnancy, women in the U.S. are exposed to more than 60 chemicals at any given time. Specifically, exposure to bisphenolic chemicals during pregnancy occurs in >90% of pregnancies and bisphenolic chemicals can cross the placental barrier reaching fetal circulation. Bisphenol A (BPA) is the leading bisphenol in exposure prevalence followed by bisphenol S (BPS). On the other hand, during pregnancy, both the fetus and the placenta are targets of chemicals that can act as endocrine disruptors (EDCs), such as bisphenols. Given the above, our laboratory is interested in understanding whether BPA and/or BPS can affect placental function and fetal growth. Studies thus far have used in vitro approaches to investigate the effects of BPA on placental invasion, transporter expression, and steroidogenesis. In our laboratory, and using a large animal model, we have first characterized internal dose exposure in the fetal compartment for both bisphenols. Additionally, our latest work has demonstrated that gestational exposure to the emerging bisphenol BPS, but not BPA, can impair placental endocrine function pointing specifically to a dysregulation in the fusogenic trophoblast signaling pathway. These findings highlight the intrinsic differences among bisphenolic chemicals and the need to evaluate the safety of BPA analogues during vulnerable windows of development.

S02.04C. Toward a Degree of Willingness to Certify Causality: Weighting  
Epidemiological and Non-Epidemiological Evidence

**S02.04.11. Introduction to the NAS Risk Assessment Document: Using 21st Century Science to  
Improve Risk-Related Evaluations**

Beate Ritz

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Abstract: The purpose of this short overview is to introduce some subjects of intense discussion during the writing of the NAS risk assessment document--"Using 21st Century Science to Improve Risk-Related Evaluations" relating to the contributions and causal reasoning in sciences contributing to risk assessment. Specifically, for environmental epidemiologic the panel discussed the use of new methods and data streams - from omics to geographic information systems and medical big data - for the purposes of risk assessment and the development of effective public health policies. The science panel summarized as advantage and challenges of epidemiology its inherently interdisciplinary nature, its struggle with the increasing complexity of scientific inquiry; and demands to integrate new knowledge from basic, clinical, and population sciences into a communicable story that can be used for policy setting and regulations.

## **S02.04.12. Systematic Review and Evidence Integration in the IARC Monographs**

Kurt Straif

*Kurt Straif<sup>1</sup>*

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Abstract: The IARC Monographs identify causes of cancer in the human environment, including chemicals, mixtures, personal habits, biological and physical agents. Since its inception in 1971 the Monographs programme has evaluated more than 1000 agents, with more than 100 classified as carcinogenic to humans and almost 400 as probably or possibly carcinogenic to humans. International Working Groups of experts evaluate human, animal and mechanistic evidence and reach a consensus evaluation of carcinogenicity. First, human and animal cancer data are evaluated separately, with the strength of the evidence for causation being categorised as Sufficient, Limited, Inadequate, or Suggesting lack of carcinogenicity. For the overall evaluation of carcinogenicity, the Working Group considers all streams of evidence and assigns agents to one of 5 groups: 1 Carcinogenic to Humans; 2A Probably carcinogenic to humans; 2B Possibly carcinogenic to humans; 3 Not classifiable as to carcinogenicity to humans, or 4 Probably not carcinogenic to humans. Strong mechanistic evidence can be invoked to upgrade or downgrade an evaluation. The Monographs' evaluations constitute hazard identification, but the Preamble provides the scope for characterising risk quantitatively. The presentation will focus on systematic review and evidence integration, and the principles that guide evidence integration within and across different streams of evidence. The discussion will be very timely to feed into the planned amendment of the Preamble in November 2018.

### **S02.04.13. Evidence--Law vs Science**

Dale Hattis

*Dale Hattis<sup>1</sup>*

*1. George Perkins Marsh Institute, Clark University, Arlington, MA, United States.*

Abstract: What counts as "evidence" in science is very different from the concept associated with the same word in law. In science, "evidence" is typically some set of observations accompanied by well-grounded theory relating those observations to some proposition. By contrast, in law, "evidence" is typically the testimony of someone in a position to know saying that a proposition is so. Think of eye-witness testimony in a murder trial, or a photograph of the alleged murder, backed up by a witness attesting to what the photo is, how and when it was taken and other relevant details. This paper explores the history of how these divergent meanings developed, and implications for how the different ideas of evidence might change in the future in the light of emerging technology and emerging scientific understanding.

## **S02.04.14. Careful-Causal Reasoning for Human Health: Paradigms, Argumentation and Perspectives from Environmental Epidemiology, Toxicology & Risk Communication**

Erik Lebret

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**Abstract:** Toxicologists and epidemiologists frequently need to work together to address environmental health issues. While many experts enjoy such inter-disciplinary interaction, many also acknowledge frustration in the process. At RIVM, epidemiologists and toxicologists are exploring the underlying cultures, issues and reasons behind such frustrations to improve the quality in content and process of their joint risk assessments. Identified differences include (in addition to many semantic differences) paradigm differences with respect to the assumption of a 'single sufficient cause' in experimental toxicology versus the assumption of a complex of 'multiple component causes' in epidemiology. The 'single sufficient cause' approach leads to the necessity to use very high exposures/dosages to establish effects in toxicological experiment. This in turn necessitates extrapolation to the much lower exposures in the human population and questions the relevance of the information in the context of 'multiple component causes'. Several 'allergies' about terminology and practice in the other discipline were identified which diminish or even disqualify the relevance of studies from the other discipline: These include the use of 'risk factor' and 'relative risk' and the practice of 'imputation of missing values' in epidemiology ('making up data' is considered misconduct in toxicology). Another allergy relates to the low rate of reproduction of studies and reproducibility of results in experimental toxicology and the practice of interpreting the exceedance of a toxicology based health standard, using 'safety factors' put on NOAELs from animal studies as an indication for adverse health outcomes in the human population. We will discuss the broader results from our analyses of causal reasoning about health risks in the population and (hidden) arguments used. In addition, we will address 'mental models' of lay people in response to risk communication from toxicology and epidemiology.

## **S02.04.15. Lessons from the Law**

Raymond Neutra

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Abstract: In the early 20th century, law professor JH Wigmore (1) proposed a procedure for graphically presenting an influence diagram linking pieces of direct and ancillary evidence and resulting assertions to warrant a final verdict. Twenty years ago, Kadane and Schum (2) took this further by showing how similar computerized influence diagrams with assertions linked by elicited likelihoods and computed relative likelihoods, could reveal the most sensitive assumptions in a legal argument. As earlier pointed out by Toulmin and Wigmore, moving from facts to assertions requires the endorsement of "generalities" to warrant the assertions and that ancillary evidence is needed to back these generalities. A body of evidence brought to trial is not comprehensive, if evidence has been excluded that: is known to be uncorrelated with the evidence already at hand and known to have potential probative value sufficient to reverse a verdict. Using Bayes' Theorem and by specifying the odds of guilt associated with "presumption of innocence" and "guilt beyond a reasonable doubt," they could define the relative likelihood conveyed by the overall evidence needed to reach that standard of proof. They applied this to the 359 pieces of evidence of the famous Sacco and Vanzetti case. I will argue that the Kadane and Schum approach may be helpful in guiding how epidemiologic and non-epidemiologic evidence should be combined to develop: A binary "verdict" of causation, assign an ordinal "convincingness rank" or an epistemic probability of causation. Any of these products of causal inference could be handed over for regulatory action. Only the last could be used to carry out a quantitative decision analysis. Brains and duty ethics may prefer verdicts or ranks.

References: 1.Wigmore J *The Science of Proof*, Little Brown Boston 1937 2.Kadane J and Schum D *A Probabilistic Analysis of the Sacco and Vanzetti Evidence*, Wiley, New York 1996

S02.04D. Exposure Science and Health Impact Assessment in Service to Community Resilience for Fugitive Chemicals

**S02.04.16. Addressing a New Species of Trouble: The Health and Social Consequences of Fugitive Chemicals Post-Disasters**

Ramya Chari

*Ramya Chari<sup>1</sup>, Jaime Madrigano<sup>1</sup>, Ryan Chavez<sup>2</sup>, Jalisa Gilmore<sup>3</sup>, Juan Camilo Osorio<sup>4</sup>, Christine Chaisson<sup>5</sup>*

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- 2. UPROSE, New York, NY, United States.*
- 3. New York City Environmental Justice Alliance, New York, NY, United States.*
- 4. Massachusetts Institute of Technology, Cambridge, MA, United States.*
- 5. The LifeLine Group, Annandale, VA, United States.*

Abstract: The combination of population growth in areas of mixed (residential, commercial, and industrial) land use along U.S. waterfronts and the increasing frequency of devastating hurricanes and storm surges, has led to community fears of widespread toxic chemical contamination resulting from accidental industrial or small business releases, particularly in the aftermath of an extreme weather event, such as a hurricane. Industrial waterfront communities, which are frequently environmental justice communities, contain numerous toxic chemical sources located in close proximity to residential housing, schools, daycare centers, playgrounds, and healthcare centers. In this presentation, the public health problem posed by "fugitive" chemicals, or previously confined chemicals dislodged by floodwater inundation, will be described. Recent examples of fugitive chemical releases and their potential physical and mental health risks will be presented. Approaches to characterize community exposure to fugitive chemicals, as well as opportunities to minimize exposure, will be discussed. The presentation will include a discussion of populations that may be particularly vulnerable to the health risks from fugitive chemicals, as well as an overview of populations to engage with when confronting this problem. Finally, gaps in the literature and opportunities for further research on the public health consequences of fugitive chemicals will be highlighted.

## **S02.04.17. The Fugitive Chemical: Predicting Its Release, Concentration into Community Areas and Subsequent Exposure to Recovery Workers**

Juan Osorio

*Juan C. Osorio<sup>1</sup>, Christine Chaisson<sup>2</sup>, Kerry Diskin<sup>4</sup>, Eddie Bautista<sup>3</sup>, Elizabeth Yeampierre<sup>5</sup>, Ryan Chavez<sup>5</sup>, Ramya Chari<sup>4</sup>, Regina Shih<sup>4</sup>, Jaime Madrigano<sup>4</sup>, Natasha Dwyer<sup>3</sup>, Erica Meza<sup>4</sup>*

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Abstract: Properly contained industrial toxic chemicals present minimal risk to adjacent residential communities until severe weather events compromise buildings and containers. Resulting chemical dislodgement and dispersion into and around residential structures present yet-to-be quantified health threats to residents and recovery workers. The partnership Grassroots Research to Action in Sunset Park (GRASP) estimated exposure and potential risks to such fugitive chemicals released into this Brooklyn neighborhood during Superstorm Sandy in 2012. Using "traditional" and "non-traditional" data sources, the community identified over 600 chemicals potentially onsite during the storm - and used GIS to map their location and potential chemical dispersion. Using 59 different chemical source points and seven different inundation scenarios, the team estimated resulting chemical concentrations at points throughout the neighborhood. GRASP estimates that recovery workers came into contact with these possible chemical residues during cleanup activities following the storm. Descriptive narrative, videos and photographs, were used to build activity profiles for exposure assessments considering multiple activity scenarios - with and without the use of protective clothing and masks. The presentation will describe data resources and methods used to inventory community-specific data, exposure assessment approaches, underlying assumptions, lessons learned, and next steps. By facilitating the co-production of knowledge through a partnership between community organizers and urban planners, risk assessment and exposure experts, this is an innovative methodology to address a public health community concern that turns research into action - building a model for other mixed-use waterfront communities.

## **S02.04.18. How Frontline Communities Can Apply the Tools of Fugitive Chemical Risk Research**

Ryan Chavez

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*1. UPROSE, Brooklyn, NY, United States.*

Abstract: This presentation will highlight how the principles and practices of community based participatory research can be used to enhance chemical exposure research, disaster preparedness, and community resilience. The speaker will illustrate the practical advantages of approaching fugitive chemical exposure research by building upon and supporting existing grassroots resiliency efforts among frontline communities. This will include methods of employing both formal data and community-driven data to address local concerns around fugitive chemical exposure. Examples will be given of how to empower communities in such research efforts, produce actionable research, and devise a research framework that serves both existing research gaps and locally-driven resiliency agendas. The speaker will highlight how such efforts are currently being used in a vulnerable industrial waterfront community in Brooklyn, New York and used to strengthen and advance several community-based resiliency efforts. This will demonstrate how fugitive chemical exposure research can be customized to reflect specific community needs while contributing and informing broader research and policy frameworks at the same time.

## **S02.04.19. A Path Forward for Protecting Against Fugitive Chemicals Under Severe Weather: Community-Based Tools, Methods, and Practices for All Communities**

Jalisa Gilmore

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Abstract: This presentation will focus on the tools and approaches that communities can use to conduct a fugitive chemical exposure assessment to build community resilience in the event of severe weather such as a major coastal storm. Lessons learned from the partnership of exposure assessment scientists and community leaders will be highlighted and the generalization of these approaches for other waterfront mixed-use communities. The approach presented in previous parts of this Session is being employed to address the threat of fugitive chemicals from chemically intense businesses (auto shops in this case study) closely integrated into the residential geography of Brooklyn. This situation is common to communities throughout the nation. Exposure and risk are assessed for nearby residents potentially exposed to fugitive chemicals remaining after storm cleanup. This empowers communities to undertake effective actions for risk avoidance, risk mitigation and/or response to existing health threats. Local industrial businesses are often the economic heart of the neighborhood, and can engage with this work to help develop "best management practices" for resilient planning and development. Other uses of the exposure and risk assessments, including training for responders and residents doing recovery work, creation of materials for frontline health professionals, and guidance for future environmental monitoring after a storm event, are also described. The presenter will focus on common resources that can be accessed across communities, as well as how to customize the implementation to individual needs and vulnerabilities of local communities. Finally, suggestions for future research and policy implementation will be proposed.

## **S02.04.20. Panel Discussion on Preparing Working Waterfront Communities to Minimize Fugitive Chemical Threats**

Christine Chaisson

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*1. The LifeLine Group, Annandale, VA, United States.*

Abstract: Working waterfront communities on rivers, lakes, bays and oceans face the threats of devastating water incursions and release of chemicals used, stored or transported through the area. When properly stored, the toxic chemicals pose little threat to workers and nearby residents, but when released into the storm waters, acute and long-term health hazards become a concern for first responders, recovery workers and the returning residents. Communities working with the waterfront and integrated industries/businesses and with exposure assessment scientists can focus action toward efficacious practices to reduce the threats and efficient methods to mitigate potential exposures. Important factors contributing to success of such undertakings depend on community/science partnership, access to local databases on chemically intense sites, exposure assessment methodologies and resources, relevant risk assessments for front line health providers, and effective community organization for action. The panel will discuss tested processes on these factors, based on the experience of past and ongoing research, avenues for expansion with disciplines that have not yet been fully incorporated into the approach, including epidemiology and health impact assessment, and the practicality of application to other working waterfront communities.

## S02.04E. Identifying Sources and Health Effects of Phenolic Consumer Product Chemicals: Product Use, Biomonitoring, and Time Trends

### S02.04.21. Maternal and Infant Exposure to Parabens, Phthalates and Phenols and the Use of Personal Care Products

Tye Arbuckle

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Abstract: Parabens, phthalates and phenols are found in a large range of personal care products and food and beverage packaging, providing the opportunity for people to be exposed on a daily basis. In 2009–2010, 80 pregnant women from Ottawa participated in the Plastics and Personal-Care Product Use in Pregnancy (P4) Study. In early pregnancy women were asked to collect multiple urine samples over 24 h on weekday and again on a weekend day, one spot urine sample in the 2nd and 3rd trimester, and again 3 months after the baby was born. Infant urine was collected shortly after birth and again 3 months later along with breast milk. We measured levels of phthalates, parabens and phenols in maternal and infant urine samples, as well as breast milk. Women kept a diary during these time periods describing the personal care product use and ingestion of packaged food. We used this information to look at associations of products used and food packaging uses with chemical concentrations in urine and breast milk. The use of some products such as lotions, shampoo, conditioner, or cosmetics in the past day was associated with higher urinary levels of parabens and some phthalates. Our data also showed higher concentrations of chemicals in urine if the product was used in the past 6 hrs. Women who used a high number of products in the past 24 h had much higher paraben concentrations (>100%) than women who were categorized as low product users. Increased breast milk paraben concentrations were also associated with use of some personal care products (skin cleansers, make up). Plastic wrap, on food consumed in the past 24 h, was associated with higher phthalate metabolites. This study suggests that pregnant women and their infants have the potential to be exposed to multiple phthalates and parabens.

## **S02.04.22. Crowdsourced Biomonitoring in a Population of Concerned Consumers Using Detox Me Action Kit**

Robin Dodson

*Robin E. Dodson<sup>1</sup>, Katherine Boronow<sup>1</sup>, Herbert Susmann<sup>1</sup>, Kathryn Rodgers<sup>1</sup>, Julia Brody<sup>1</sup>, Ruthann Rudel<sup>1</sup>*

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**Abstract:** We sought to identify sources of twelve environmental phenols in a population highly motivated to learn about their personal chemical exposures. Over 300 people, most of whom were already connected to an environmental health network, signed up for Detox Me Action Kit as part of an online crowdfunding campaign in 2017. To our knowledge this is the first biomonitoring cohort to use this recruitment strategy. Participants collected two urine samples at home and completed an online questionnaire about exposure-related behaviors. Samples were returned frozen via overnight mail, and then composited and analyzed for parabens, bisphenols, chlorinated phenols, antimicrobials, and a UV filter. Participants received their personal exposure results as an interactive web-report. Over half the participants who completed the questionnaire reported avoiding products containing BPA, triclosan, and parabens, and measured urinary concentrations were generally lower than those reported in the National Health and Nutrition Examination Survey (NHANES). These results suggest that participants were already aware of environmental chemicals and taking steps to reduce exposures. However, intentions to avoid ingredients did not always translate to dependable behavior or to lower exposure levels. After checking the labels of their products, over a quarter of the 112 female participants who reported avoiding products containing parabens found that they used at least one personal care product where parabens was a listed ingredient. In the case of bisphenols, while participants had lower levels of the widely-scrutinized chemical BPA-in line with self-reported intentions-levels of BPF in our cohort were higher compared to levels from the 2013-2014 NHANES cycle. In this example of regrettable substitution, manufacturers may be substituting closely-related chemicals in "BPA-free" products, or in products more broadly. We explored these and other relationships in this cohort of engaged participants.

## **S02.04.23. German Environmental Specimen Bank (ESB): Time Trends of Paraben Exposure**

Marike Kolossa-Gehring

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Abstract: Parabens are used as preservatives e.g. in cosmetics and body care products. They have allergenic and estrogenic properties. According to the European Scientific Committee on Consumer Products (SCCP) the toxicological data available for isopropyl-, isobutyl-, pentyl-, benzyl- and phenyl-paraben do not allow for the assessment of their health impact. Therefore, since 2014, these parabens are prohibited in cosmetic products in Europe (Commission Regulation (EU) No 358/2011): For n-propyl- and n-butyl-parabene the maximum percentage was reduced to 0.19% (0.14% as acid) for each compound. Internal exposure time trends for young adults aged 20 to 29 years were analyzed in 24 h-urine samples collected by the ESB for 6 parabens (methyl-, ethyl-, iso-propyl, n-propyl, iso-butyl, and n-butyl-paraben), covering the period from 1995 to 2017. Parabens were determined after enzymatic hydrolysis via HPLC-MS/MS. The limit of quantification (LOQ) was 0.5 µg/L. In 1995 10% of the samples contained isobutyl-paraben levels above LOQ. As a maximum, a fraction of 30% was observed in 2007 and 2008. In 2017 it was found in none of the samples. The fraction of levels at or above LOQ for n-butyl-paraben decreased from 27% in 1995 to 5% in 2017 (2004: 53 %). Although the use of ethyl-paraben had been classified as acceptable by the SCCS, exposure slightly decreased: The fraction of levels at or above LOQ decreased from 85% in 1995 to 67% in 2017. Methyl-paraben was detected in all samples analysed. Apart from decreasing detection rates urinary concentrations started to drop considerably in recent years for all parabens. For further elucidating the trend, similar studies in other European countries are warranted. The decline in exposure can be considered a positive result from a precautionary standpoint. However, health based guidance values are needed for substantiated evaluation of human exposure levels.

## **S02.04.24. Racial/Ethnic Variations in Personal and Home Product Use in Pregnant Women**

Tamarra James-Todd

*Marissa Grenon<sup>1</sup>, Andrea Bellavia<sup>1</sup>, David Cantonwine<sup>2</sup>, Ellen Seely<sup>2</sup>, Thomas McElrath<sup>2</sup>, Tamarra James-Todd<sup>1</sup>*

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**Abstract:** Background: Pregnancy exposure to endocrine-disrupting chemicals (EDCs) varies across racial/ethnic groups, which could increase the risk of certain pregnancy complications and adverse reproductive health outcomes in disadvantaged populations. Identification of modifiable sources of EDCs that are unequally distributed by race/ethnicity is required to design effective public health interventions. Therefore, we evaluated differences in product use associated with EDC exposure in a diverse pregnancy cohort. Methods: We included a total of 437 women from the LIFECODES pregnancy cohort study (Boston, MA) who completed a self-reported questionnaire in the 1st and/or 2nd trimester (median 9.9 and 26 weeks gestation, respectively). Race/ethnicity was categorized as: White, Black, Asian, Hispanic, Other. The use of 19 products (13 personal care, 6 home) within 48 hours of the prenatal visit was reported. We calculated the proportion of each product use, as well as the total number of products used by racial/ethnic group. We also evaluated change in product use between the two time periods. Results: Compared to Asian and Black women, white and Hispanic reported a significantly higher use of total products in the 1st trimester (Asians: 6, 95% CI:5.5,7.4; Black: 7, 95% CI:6.2,7.8; white: 8, 95% CI:7.9,8.5; Hispanic: 9, 95% CI:8.2,9.4). Differences were mainly driven by higher use of personal care products and remained similar in the 2nd trimester. A significant reduction over time in total, personal care, and home products used was observed only among Hispanic women (-1.4, 95% CI:-1.9,-0.9; -0.8, 95% CI:-1.3,-0.3; -0.6, 95% CI:-1.1,-0.2), respectively). Conclusions: In a pregnancy cohort, we observed significant racial/ethnic differences in use of personal care and home products known to be sources of EDCs. Future studies should investigate how these usage patterns could contribute to racial/ethnic disparities in reproductive outcomes known to be associated with EDCs.

## **S02.04.25. Associations of Prenatal Exposure to Triclosan and Benzophenone-3 with Visual Recognition Memory in 7.5-Month-Old Infants**

Kelsey Dzwilewski

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- 5. Channing Division of Network Medicine, Department of Medicine and Department of Environmental Health, Brigham and Women's Hospital and Harvard Medical School and Harvard T.H. Chan School of Public Health, Boston, MA, United States.*

Abstract: Triclosan (TCS) is used in personal care products as an antimicrobial agent and benzophenone-3 (BP3) is used in personal care products and plastics as an ultraviolet absorber. Due to their endocrine disrupting properties, prenatal exposure to these chemicals may affect brain development, but little is known about their effect on infant cognition. Prenatal exposure to TCS and BP3 and visual recognition memory (measured by novelty preference) were assessed in 177 7.5-month-old infants participating in a prospective study in Illinois, USA. Study mothers were mostly white (86%), with 88% having at least a college education and 75% a household income above \$60,000. In a pool of five first morning urine samples collected across pregnancy, we quantified (median[IQR]) TCS (14.1[63.1] µg/L) and BP3 (118.6[273.0] µg/L). Infrared eye tracking recorded infant looking time at a trial with two identical faces followed by trials in which the familiar face was paired with a novel face. General linear models were used to assess associations of each exposure biomarker (adjusted for urine specific gravity) with novelty preference (percent time looking at the novel face) adjusted for infant age, gestational age, birth weight, sex, assessment condition, household income, and maternal IQ and education. There were no associations of TCS or BP3 with novelty preference and no sex differences in associations. Each IQR increase in TCS was associated with a 0.10% decrease (95% CI: -0.49,0.29) in novelty preference, while each IQR increase in BP3 was associated with a 0.04% increase (95% CI: -0.38,0.47). Generalized additive models showed no evidence of nonlinear associations of either TCS or BP3 with novelty preference. This preliminary analysis found no evidence associating maternal prenatal urinary TCS or BP3 with infants' recognition memory at 7.5 months, but the results need to be confirmed in a larger sample. Acknowledgements: NIEHS ES007326, ES022848, ES028607, OD023272, USEPA RD83543401

## S02.04F. Strengthening Exposure Assessment in Environmental Epidemiology: Problem Identification and Suggestions for Path Forward

### **S02.04.26. Lessons Learned from Trying to Set Guidance Values Using Human Studies**

Carol Burns

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Abstract: The research focus for occupational epidemiologists is safety. How can our study subjects work safely? Guidance values are established to protect employees and the general population(s). Examples of these environmental "exposures" can include uneven surfaces, physical exertion, repetition, temperature extremes, and contact with a chemical. Regulatory bodies use data from multiple disciplines to set a number, a guidance value, to inform protective practices and legal uses. Epidemiology studies, while well suited to evaluate human health and contribute to this process, often fall short in this risk assessment process. Several observations will be discussed. First, qualitative estimates such as low vs. high, and regression coefficients are not designed to test whether a unit value is protective. Second, exposure estimates are rarely harmonized across epidemiology studies, (i.e. using the same categories for low vs. high), or across disciplines (i.e. using dose in mg/kg/day vs. concentration in ug/l). Lastly, recommendations to improve the quality, reliability and validity of exposure data for risk assessment have been promulgated but not embraced by the epidemiology community due to feasibility, as one example. Before making additional recommendations, we first need to identify and resolve barriers to be successful in changing the status quo.

## **S02.04.27. Integration of Exposure Science and Epidemiology in Environmental Research: Challenges and Strengths in Using Meta-Analyses to Quantify Non-Occupational Pesticide Exposure Intensity**

Nicole Deziel

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**Abstract:** Meta-analysis is a useful tool for synthesizing exposure data across different studies. An example is the application of meta-regression models to develop weighting factors in a quantitative, active ingredient-specific algorithm for cumulative non-occupational pesticide exposure intensity for spouses of farmers applying pesticides. The algorithm addressed three exposure pathways: take-home, agricultural drift, and residential pesticide use. The meta-analysis process presented several challenges and strengths and illuminated some of the differences across the literature. **Challenges:** First, although biological monitoring is a more direct exposure assessment method, it was necessary to rely on studies measuring pesticides in house dust as an exposure surrogate, because house dust represents a time frame more appropriate for the chronic diseases of interest, and detection rates and variability in reported biomarker concentrations were low. Second, the magnitude of pathway effects may have been overestimated because studies observing no association between house dust pesticide levels and a specific pathway often did not report summary statistics and could not be included in the meta-regression. Third, though inclusion of more detailed information may have yielded better predictions with dust pesticide concentrations, the number of studies presenting similar additional information was in some cases too sparse to model. **Strengths:** The meta-analysis framework provided an opportunity to quantify and synthesize relative differences in pesticide exposure intensity from different pathways across studies of different active ingredients in different regions and using different methodologies. Meta-regression models can be updated when new data become available. Meta-regression results can inform the development of data-driven environmental exposure categorizations for epidemiologic studies.

## **S02.04.28. Health Risk Assessment: The Need of Study Design Improvement to Accommodate Individual Susceptibilities**

Josino Moreira

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"Abstract: Scientific and technologic advances and still existing knowledge gaps have been identified in recent exposure and risk evaluation reports. New tools for evaluating and preventing negative impacts of unhealthy environments on human health, i.e. advances in computer sciences and omic techniques, promote better integration between exposure sciences and environmental epidemiology. The National Academies of Sciences, Engineering and Medicine states: "a primary objective for improving exposure science is to build confidence in exposure estimates used to support risk-based decision-making by enhancing quality, expanding coverage, and reducing uncertainty"", indicating that confidence in exposure estimates depends on data quality and risk estimation methodology accuracy. Unfortunately, no Brazilian guidelines exist, and we apply those proposed by USEPA, ATSDR, WHO or the EC. Even standards used for comparisons are determined abroad. As phenotype is linked to the environment and is regional, we ask: Are we really assessing risk for Brazilians? In fact, individual heterogeneity (genetic characteristics, health status, age, gender, stress, living environment) may influence both exposure and disease, e.g. Amazon communities ingest high mercury levels through fish but do not show intoxication signs by WHO standards, and significant discrepancies between studies in the area are noted, demonstrating the need for standardized approaches. Even under risk management policies, unexpected toxicity and adverse events may occur, often in hypersensitive individuals or small, undetected, susceptible groups. As both intrinsic and extrinsic factors determine individual susceptibility they should be incorporated in risk assessment protocols, and novel analytical approaches are required in this regard. Thus, incorporating population susceptibility measurements into risk assessment is essential to address these particularities and improve risk management in the age of precision medicine. "

## **S02.04.29. Strengths and Limitations: Integration of Exposure Sciences and Epidemiology in Health Risk Assessment of Environmental Contaminants**

Roel Vermeulen

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Abstract: Risk assessment of environmental contaminants is based on an integrated evaluation of in-vitro, in-vivo and human data. More than a 100.000 new chemicals have been synthesized in the last 5 decades. A few thousand of these have become wide-spread in the environment. Of these many have not undergone testing for safety or toxicity as thorough pre-market testing has only been institutionalized in the last decade in some regions of the world. Additionally, toxicity tests are not a 100% predictive for adverse human health effects in itself. Therefore, environmental epidemiology plays a key role in post-market research and can play a role in both hazard and risk characterization. As more epidemiological studies have become available in more recent years their use in risk assessment has increased. For example, the Dutch Health Council committee on cancer risk values has increasingly used epidemiological studies to set such limits (increasing from 0% in 1995 to 25% in 2013 of all evaluations in that time period). However, the utility of environmental epidemiology in risk assessment depends strongly on the quality of the exposure assessment. For example, in a hazard evaluation we conducted for electromagnetic low field (ELF-MF) exposure and risk of Amyotrophic Lateral Sclerosis (ALS), studies that had limitations in the exposure assessment did not show a clear association while studies that had better exposure assessment showed a clear increased risk between ELF-MF exposure and ALS. Similarly, in a risk evaluation of asbestos exposure and lung cancer, we observed a difference in risk per unit of exposure of a factor of 4 between the best to all studies. These two examples are indicative of the importance of good quality exposure assessment in epidemiological studies. In order to facilitate the transparent use of epidemiological studies in risk assessment evaluation tools for study design (e.g. ROBINS-E) with a strong focus on exposure assessment quality should be used.

## S02.04G. The Global Burden Estimates of the Impacts of Air Pollution: Methods, Innovative Applications, and WHO Results

### **S02.04.31. Assessing the Recent Estimates of the Global Burden of Disease for Ambient Air Pollution: Methodological Changes and Implications for Low- and Middle-Income Countries**

Joseph Spadaro

*Bart Ostro<sup>1</sup>, Joseph Spadaro<sup>2</sup>, Sophie Gumy<sup>3</sup>, Pierpaolo Mudu<sup>3</sup>, Yewande Awe<sup>6</sup>, Francesco Forastiere<sup>4</sup>, Annette Peters<sup>5</sup>*

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**Abstract:** The Global Burden of Disease (GBD) is a comparative assessment of the health impact of the major and well-established risk factors, including ambient air pollution (AAP), assessed by concentrations of PM<sub>2.5</sub> (particles less than 2.5 microns) and ozone. Over the last two decades, major improvements have emerged for two important inputs in the methodology for estimating the impacts of PM<sub>2.5</sub>: The assessment of global exposure to PM<sub>2.5</sub> and the development of integrated exposure risk models (IERS) that relate the entire range of exposures to PM<sub>2.5</sub> to cause-specific mortality risks. As a result, the estimated annual mortality attributed to AAP increased from less than 1 million in 2000 to roughly 3 million for GBD in years 2010 and 2013, and to 4.2 million for GBD 2015. However, the magnitude of the recent change and uncertainty regarding its rationale have resulted, in some cases, in skepticism and reduced confidence in the overall estimates. To understand the underlying reasons for the change in mortality, we examined the estimates for the years 2013 and 2015 to determine the quantitative implications of alternative model input assumptions. We calculated that the year 2013 estimates increased by 8% after applying the updated exposure methods used in GBD 2015, and increased by 23% with the application of the updated IERS from GBD 2015. The application of both upgraded methodologies together increased the GBD 2013 estimates by 35% or about one million deaths. We also determined the impact of changes in demographics and assumptions about the threshold concentration. Since the global estimates of air pollution-related deaths will continue to change over time, a clear documentation of the modifications in the methodology and their impacts is necessary. In addition, there is need for additional monitoring and epidemiological studies to reduce uncertainties in the estimates for low- and medium-income countries.

## **S02.04.32. From Satellites to Burden: New Approaches to Assessing the Global Burden Associated with Ambient Air Pollution**

Gavin Shaddick

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*1. University of Exeter, Exeter, United Kingdom.*

Abstract: In order to estimate the burden of disease attributable to fine particulate ambient air pollution, country-level estimates of population-level exposures, together with associated measures of uncertainty, are required. The primary source of information for estimating exposures has been measurements from ground monitoring networks but, although coverage is increasing, there remain regions in which monitoring is limited. Ground monitoring data therefore needs to be supplemented with information from other sources, such as satellite retrievals of aerosol optical depth and chemical transport models. A hierarchical modelling approach for integrating data from multiple sources is proposed allowing spatially-varying relationships between ground measurements and other factors that estimate air quality. Temporal trends are modelled by allowing relationships to change, smoothly, over time. Set within a Bayesian framework, the resulting Data Integration Model for Air Quality (DIMAQ) is used to estimate exposures on a high-resolution grid covering the entire world. For each grid-cell, a full posterior distribution (of exposures) is produced, allowing point estimates (e.g. means, medians), measures of uncertainty (e.g. credible intervals) and exceedance probabilities (e.g. probability of being over guidelines) to be calculated. Bayesian analysis on this scale can be computationally challenging and here approximate Bayesian inference is performed using Integrated Nested Laplace Approximations (INLA). Estimated exposures from the model, produced on a high-resolution grid (10km x 10km) covering the entire globe, are combined with risk estimates to produce a global assessment of exposures to PM<sub>2.5</sub> over time (2010-2016) and to estimate the associated burden of disease attributable to air pollution.

### **S02.04.33. Global Mortality and Long-Term Ambient Exposure to Fine Particulate Matter: A New Relative Risk Estimator**

Richard Burnett

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**Abstract:** Exposure to ambient fine particulate matter (PM<sub>2.5</sub>) is a major global health concern, accounting for over 4 million premature deaths in 2015. This estimate is based on a mortality relative risk model that incorporates information from multiple PM<sub>2.5</sub> sources (ambient and indoor air pollution, second hand and active smoking), requiring assumptions about equivalent exposure and toxicity among sources. We relax these contentious assumptions by constructing the first PM<sub>2.5</sub>-mortality relative risk function based only on cohort studies of ambient air pollution that covers the global exposure range. We modelled the shape of the association between PM<sub>2.5</sub> and non-accidental mortality, the Global Exposure Mortality Model (GEMM), using data from 41 cohorts covering 16 countries, including recent epidemiological evidence from Asia. We restricted burden assessments to non-communicable disease plus LRI for those over the age of 25 years as this group represents almost all the causes of death in the cohorts used to estimate the GEMM associations. We also constructed GEMMs for five specific causes of death examined by the Global Burden of Disease (GBD): ischemic heart disease, stroke, chronic obstructive lung disease, lung cancer, and lower respiratory infections (LRI) to estimate global PM<sub>2.5</sub> deaths in 2015. GEMM predicts 8.9 million (95% confidence interval (CI): 7.5-10.3), a figure 30% larger than that predicted by the sum of deaths among the five specific causes (6.9, 95% CI: 4.9-8.5), and 220% larger than the risk functions used in the GBD (4.0, 95% CI: 3.3-4.8). About half of the predicted global mortality is attributed to low and lower middle-income countries, where exposure and population vulnerability is highest. These results suggest that PM<sub>2.5</sub> exposure may be related to additional causes of death than the five considered by GBD, and that incorporation of other, non-ambient, particle sources, leads to under-estimates of disease burden especially at higher concentrations.

## **S02.04.34. The World Health Organization (WHO) Global Estimates of the Impact of Air Pollution**

Sophie Gumy

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Abstract: Air pollution has been identified as a global health priority in the sustainable development agenda. The World Health Organization (WHO) has responsibility for stewarding three air pollution-related indicators for monitoring progress against the Sustainable Development Goals (SDGs): in health (Goal 3) - mortality from air pollution, in cities (Goal 11) - air quality in cities, and in energy (Goal 7) - access to clean fuels and technologies. This session will present WHO updated global estimates of exposure and burden of disease from air pollution from particulate matter, which are used for SDG reporting at the global, regional and national level. These estimates are based on improved exposure estimates and integrated exposure risk models. Over the last two decades, there has been considerable improvement in two important inputs of the methodology for estimating the impacts of PM<sub>2.5</sub>: The assessment of global exposure to PM<sub>2.5</sub> using satellite data and its integration with ground measurements, and the development of integrated exposure risk models (IERs) that relate the entire range of exposures to PM<sub>2.5</sub> to cause-specific mortality risks. To date, air pollution - both ambient and household - is the biggest environmental risk to health, carrying responsibility for about one in every 8 deaths annually. Ambient (outdoor) air pollution alone kills around 4 million people each year, mainly from noncommunicable diseases. To support countries in choosing policies aiming at reducing air pollution and promoting health, WHO is further developing and refining tools to support planning for clean household energy policies (the Clean Household Energy Solutions Toolkit); to quantify the health impacts of air pollution (AirQ+ software); and to estimate the expected health impacts from policies taken by other sectors (for example, transport, waste management, and land-use planning).

## **S02.04.35. Impact Assessment at Global and Local Level Using the WHO Software AirQ+**

Pierpaolo Mudu

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Abstract: Air pollution is the most important environmental risk factor to health and has been identified as a global health priority in the sustainable development agenda, and also by the World Health Organization (WHO). Quantifying the effects of exposure to air pollution in terms of public health has become a critical component in policy discussion. The WHO Regional Office for Europe has developed AirQ+ software within its activities on air quality and health. AirQ+ is designed to calculate the magnitude of the impacts of air pollution on health in a given population. It handles long- and short-term exposure to ambient air pollution from several pollutants and long-term exposure to household air pollution from polluting fuel use. Pollutants considered include particulate matter, nitrogen dioxide, black carbon, and ozone. AirQ+ can be used for any city, country or region to estimate: 1) How much of a particular health outcome is attributable to selected air pollutants? 2) Compared to the current scenario, what would be the change in health effects if air pollution levels changed in the future? All calculations performed by AirQ+ are based on methodologies and concentration-response functions established by epidemiological studies. The concentration - response functions used in the software are based on systematic reviews of all studies available and their meta-analysis.

Wednesday, August 29

O03.01A. Carbon Monoxide and Radon in Residential Buildings

**O03.01.01. A Mixed Methods Approach to Radon Health Risk Perception of Ottawa Residents**

Selim Khan

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Abstract: Background: Canadians have reason to care for indoor air quality as they spend over 90% of their time indoors. The geographic location and old houses make Ottawa residents at risk of the high level of radon exposure. Indoor radon causes more deaths than any other environmental hazards. While 55% residents are aware of the health risk, only 6% have taken action. Objective: To understand residents' perceptions of the health risks of radon and to assess their perceived need to take action. Methods: In mixed methods approach, an online survey (N=308) with Qualtrics and semi-structured face to face qualitative interviews (N=35) were conducted with both homeowners and tenants in Ottawa. These quantified and explored residents' perception of and adaptations for the risk. Quantitative data were analyzed in SPSS and qualitative analysis was done in Atlas-Ti using a two-coder iterative content approach. Results: The majority of participants were Caucasian (77%), male (51%), homeowners (72%), and under age 65 (71%). Overall, 34% residents have some concerns about radon health risk, 12% have tested, and only 4% mitigated their homes for radon. Residents' perception of the severity of the risk, social influence, and smoking history significantly correlate with their intention to test for radon whereas synergistic risk perception with smoking predicts the perception of severity of the risk. Three themes emerged from qualitative analyses of interviews: 1) despite the gravity of radon health risks, there are minimum government programs to inform residents. 2) residents' concern about the risk and care for family welfare motivate them to take action. 3) health communication program should tap into the emotional aspect of awareness beyond the cognitive awareness. Conclusions: There are inadequate government initiatives, and the health communication messages remained ineffective. Policy should address the shared responsibility of both government and residents in tackling the issue.

### **O03.01.02. Protecting Populations from Radon in Ontario, Canada: Translating Research to Evidence-Based Public Health Practice**

Elaina MacIntyre

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Abstract: Radon is a ubiquitous public health hazard and the second leading preventable cause of lung cancer. Public Health Ontario (PHO) has been engaged in various activities to promote local level public health action on radon since 2013. This presentation will describe how these applied research projects have resulted in effective action to understand and mitigate radon exposure in Ontario. In 2013, PHO estimated that 847 lung cancer deaths per year were attributable to radon. PHO presented these results at various meetings, and in an online infographic and interactive report to highlight findings by region and identify strategies for local level public health practitioners to address radon. In 2016, PHO partnered with Cancer Care Ontario to estimate the cancer burden of environmental hazards and identified radon as the second leading carcinogen in terms of projected future cancer cases (1,310 per year). This was followed by a 1-day event for local level public health practitioners to share strategies and lessons learned in addressing radon at the local level. In late 2017, PHO conducted an online survey to identify how radon was being addressed by local level public health. There were over 100 specific activities targeting radon in one of 4 categories: responding to public concern (28%), public education activities (43%), measurement campaigns (13%), and 'other' (16%). Between 2013 and 2016, the number of public health authorities engaged in radon activities increased 6-fold. In early 2018, a new Ontario Healthy Environments and Climate Change Guideline was released to provide direction to local health authorities on how to approach specific public health requirements around radon (implementing public awareness initiatives and mitigation strategies). This marks the first time radon has been included in official guidance for public health practitioners in Ontario, and illustrates the provincial impact of building capacity at the local level for priority health hazards.

### **003.01.03. Association of Indoor Air Pollutants and Cardiovascular Hemodynamics**

YunShan Chung

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**Abstract:** Backgrounds: Indoor air quality has been associated with human health, however, there is limited information regarding personalized indoor air pollutants and cardiovascular hemodynamics. This study aims to investigate the concurrent real-time monitoring of indoor air quality and cardiovascular function. Methods: During July-October 2017, we recruited 40 subjects from 31 family for this study. Concurrent 24-h real-time monitoring of indoor air quality and cardiovascular hemodynamics were performed for each participant. Cardiovascular hemodynamics were measured via arterial pressure waveform by a cuff sphygmomanometer using an oscillometric BP device (DynaPulse 200M, Pulse Metric Inc., San Diego, CA). Time series analysis was applied to estimate the change of cardiovascular hemodynamics for every one unit (different scales) increase of air pollutants for 40 subjects. Results: The median (IQR) concentration of 24-hour indoor air pollutants were 28.80 (23.98)  $\mu\text{m}^3$  for PM<sub>2.5</sub>, 30.47(25.03)  $\mu\text{g}/\text{m}^3$  for PM<sub>10</sub>, 0.487(0.667)  $\mu\text{g}/\text{m}^3$  for carbon monoxide (CO), and 452.0 (295.0)  $\mu\text{g}/\text{m}^3$  for carbon dioxide (CO<sub>2</sub>). Time series analysis showed for every 1  $\mu\text{g}/\text{m}^3$  increase of indoor CO exposure, cardiovascular hemodynamics would increase 1.403(0.095-2.712) and 1.397(0.081-2.712) mmHg in concurrent and lag 1h systolic blood pressure respectively. In addition, the corresponding change of cardiac output would increase by 70 (13-127) ml and 73(14-132) ml for lag 1h and lag 4h respectively. For every 100  $\mu\text{g}/\text{m}^3$  increase in indoor CO<sub>2</sub> exposure, the concurrent and lag 1h cardiac output would increase by 24.1(4.9-43.3) ml and 31(12.8-49.2) ml respectively. Conclusion: Real-time indoor air quality monitoring of CO and CO<sub>2</sub> was strongly associated with personalized 24h cardiovascular hemodynamics.

#### **O03.01.04. Descriptive Epidemiology of Hospital Admissions Due to Carbon Monoxide Poisoning in England, between 2008 and 2015**

Aina Roca Barceló

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**Abstract:** Background Data on carbon monoxide poisoning (CO<sub>p</sub>) for England and other high-income countries are relatively limited. We aimed to provide updated data on hospital admissions for intentional, accidental non-fire related (ANFR), and unknown causes of CO<sub>p</sub> in England (2008-2015). **Methods** Hospital admissions for England with a primary diagnosis of CO<sub>p</sub> were collected. Rates per 100,000 inhabitants were estimated by age group, sex, calendar-year and ethnicity, using population estimates for England, and used to analyse temporal trends with log-linear models. Changes are shown as Annual Percent Change (APC). Deprivation, defined as quintiles of the Carstairs index, and seasonal patterns were also investigated. **Results** Overall, we identified 3,686 CO<sub>p</sub> hospital admissions (58% accidental of which 89% were ANFR; 35% intentional, and 6% of unknown cause), corresponding to an average of 460 CO<sub>p</sub> admissions/year. Preliminary results show a significant decrease in the number of intentional CO<sub>p</sub> admissions in both men (APC: -9.63%, p<0.05) and women (APC: -8.03%, p<0.05) over the 8 year period; ANFR CO<sub>p</sub> admissions decreased significantly only in women (APC: -6.35%). The largest proportions of ANFR CO<sub>p</sub> cases occurred during the winter months (males: 30.8%; females: 35.5%), among the most deprived (~28%, both genders) and in patients over 80yrs (men: 1.59 OR; women: 1.38 OR). Intentional CO<sub>p</sub> was most common among men aged 30-60yrs and showed no seasonal pattern. Higher rates of ANFR and intentional CO<sub>p</sub> were found in black/black British and white/white British, respectively. **Conclusions** Nationally, this study shows a significant decrease over the study period in hospital admissions for intentional CO<sub>p</sub> in both genders, and for ANFR CO<sub>p</sub> in women. We found demographic differences, with a greater proportion of hospital admissions for ANFR CO<sub>p</sub> in women, the over 80 year olds, black/black British and highly deprived groups. The reasons for these changes are being investigated.

## O03.01B Estimating Air Pollution Exposures and Health Outcomes Associated with Wildfires

### O03.01.05. A Machine Learning Approach to Estimate Hourly Exposure to Wildfire Smoke for Urban, Rural, and Remote Population

Jiayun Yao

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Abstract: Increases in wildfire frequency and intensity have been observed over recent decades, and are expected to continue with climate change. Exposure to wildfire smoke has been associated with a wide range of acute cardiopulmonary outcomes, but most of the epidemiologic evidence is based on exposures averaged over the 24-hour period on the day of the observed outcomes. Little is known about the effects of sub-daily exposures immediately preceding acute events such as myocardial infarction, stroke, or exacerbations of chronic respiratory diseases. Thus, it remains unclear to what extent the cardiopulmonary effects of wildfire smoke can be attributed to short (i.e. hours) but extreme levels of exposure compared with longer (i.e. days) periods of cumulative exposure. One big challenge for studying sub-daily effects is the lack of spatially and temporally resolved estimates of smoke exposures. Although some deterministic air pollution models can provide sufficient resolution, they require extensive expertise and computing power, and have large uncertainty in performance. As an alternative, we developed a Random Forests machine learning approach to estimate 1-hour average population exposure to fine particulate matter during wildfire seasons from 2010 to 2015 in British Columbia, Canada, at a 5km by 5km resolution. The model used data from available air quality monitors, remotely sensed fire activity, meteorology assimilated from satellite data and modeling, as well as geographic and ecological information. The final model explained 83% of the variance in out-of-sample evaluation, with low mean fraction bias of -0.31%. This performance was sustained across years and locations. Two case studies showed a high degree of spatial and temporal agreement between model predictions and observations. This model will be useful for conducting epidemiologic studies on sub-daily exposure to wildfire smoke, as well as informing public health actions once operationalized in near-real-time.

### **O03.01.06. Cardiovascular and Cerebrovascular Emergency Department Events Related to California Wildfires in 2015**

Ana Rappold

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**Abstract:** Fine particulate matter (PM<sub>2.5</sub>) found in smoke can exacerbate respiratory conditions; however, evidence for cardiovascular and cerebrovascular events has been inconsistent. **Methods:** We conducted a time series analysis of adult cardiovascular and cerebrovascular events for the 2015 wildfire season in 8 California Air Basins. We used estimated fire-PM<sub>2.5</sub> concentrations and satellite data from the Hazard Mapping System together with California statewide emergency department (ED) data at the ZIP code-level. Age- and gender-stratified population subsets were modeled with lags up to 5 days and models were adjusted for adjusted for seasonal trend, day of the week and heat index. **Results:** All-cause cardiovascular ED visits across all lags were elevated (RR of 1.07, 95%CI[1.05, 1.09]), as were all-cause cerebrovascular (1.13 [1.05-1.21]), and all-cause respiratory visits (1.10 [1.08,1.12]). No significant association was found for the control condition of acute appendicitis (0.93 [0.81,1.06]). Elevated individual diagnoses included ischemic heart disease (1.09 [1.05, 1.13]), heart failure (1.10 [1.06,1.14]), and dysrhythmia (1.14 [1.11,1.17]). Ischemic strokes were elevated up to 5 lag days for adults 65 years and older (1.21 [1.05, 1.37]). Dose-dependent responses were observed for fire-PM<sub>2.5</sub> and nearly all diagnosis categories, across all 5 lags. **Conclusions:** Wildfire PM<sub>2.5</sub> elevated the risk of cardiovascular and cerebrovascular ED visits. This abstract does not necessarily reflect US EPA views and policies.

### **O03.01.07. A Causal Inference Analysis of the Effect of Wildland Fire Smoke on Ambient Air Pollution Levels and the Associated Health Burden from Wildfire-Contributed PM2.5**

Alexandra Larsen

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Abstract: Wildfire smoke contains hazardous levels of fine particulate matter (PM2.5), a pollutant shown to adversely affect respiratory and cardiovascular health. Estimating PM2.5 concentrations attributable to wildfires is key to understanding the extent to which wildfires contribute to poor air quality and subsequent health burdens. This is a challenging problem since only total PM2.5 is measured at monitoring stations in the U.S., meaning we only ever observe PM2.5 from all sources (wildfire smoke, anthropogenic sources, natural non-fire sources, etc.). We propose a method for separating estimates of wildfire-contributed PM2.5 from ambient PM2.5 concentrations using a novel causal inference framework and bias-adjusted computer simulations of PM2.5 under counterfactual scenarios. The numerical PM2.5 data for this analysis is from the Community Multi-Scale Air Quality (CMAQ) Modeling System, run with and without fire emissions across the contiguous U.S. for the 2008-2012 fire seasons. To account for biases, the CMAQ output is calibrated with observed data from the U.S. Environmental Protection Agency's Federal Reference Method (FRM) PM2.5 monitoring sites for the same spatial domain and time period. We use a Bayesian model that accounts for spatial variation to estimate the effect of wildfires on PM2.5 and state assumptions under which the estimate has a valid causal interpretation. Our results include estimates of absolute, relative and cumulative contributions of wildfire smoke to PM2.5 for the contiguous U.S. Additionally, we compute the health burden associated with the PM2.5 attributable to wildfire smoke. Our results provide insight into using causal inference with numerical and spatial data, as well as a method that we extend to investigate the causal effects of wildfire smoke on public health outcomes. Disclaimer: This work does not necessarily represent EPA views or policy.

### **003.01.08. The British Columbia Asthma Prediction System (BCAPS): A Surveillance System to Forecast the Public Health Impacts of Wildfire Smoke**

Kathleen McLean

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**Abstract:** Smoke from severe wildfires during the summers of 2015 and 2017 affected most of the population of British Columbia (BC), Canada. Asthma-related health outcomes are consistently elevated when populations are exposed to wildfire smoke in BC. Timely information during smoke events is important to inform the actions of public health authorities. We developed a surveillance system using short-term wildfire smoke forecasts to predict the potential health impacts of smoke over the coming days and provide this information to public health authorities in easy-to-interpret daily reports. The BCAPS framework is modular such that different data, modelling approaches, and visualizations can be applied. We used daily fine particulate matter (PM<sub>2.5</sub>) measurements, daily counts of asthma-related population health outcomes, and PM<sub>2.5</sub> forecasts to predict and visualize smoke exposures and their health impacts across different geographic areas over the coming 48 hours. We applied BCAPS retrospectively during a 2015 smoke event using a Bayesian latent process model to forecast health outcomes. We prospectively applied BCAPS in 2017 using random forest models to predict PM<sub>2.5</sub> exposure and health outcomes. Daily PM<sub>2.5</sub> measurements ranged from 0.03 µg/m<sup>3</sup> to 301.2 µg/m<sup>3</sup> during the 2015 event and from 0.05 µg/m<sup>3</sup> to 293.8 µg/m<sup>3</sup> in 2017. Daily PM<sub>2.5</sub> and daily counts of asthma-related physician visits and medication dispensations were increased during smoky periods in 2015 and 2017. In general, BCAPS predicted the smoke-related increases in asthma outcomes with good accuracy, though performance was dependant on the performance of the smoke forecasts. In 2017 there was a marked decrease in population response to smoke towards the end of the season even though PM<sub>2.5</sub> concentrations remained high. Integrating data from multiple sources into a modular framework such as BCAPS can usefully predict the health impacts of smoke exposure in a timely manner to inform public health decision-making and action.

## O03.01C. Impacts and Evaluation of Arsenic Exposures

### **O03.01.09. Preliminary Quantitative Risk Assessment: Arsenic Exposure from Drinking Water on the Hopi Lands**

Jonathan Blohm

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**Abstract:** Introduction: Water quality data from Native American lands in Northern Arizona is limited. The effect of long-term exposure to arsenic in drinking water may influence the development of later onset cancers and pulmonary diseases and are of concern to the Hopi Tribe. Methods: Since December of 2017, tap water and urine samples have been collected from 18 households on Hopi lands. Tap water and urine samples were evaluated for speciated arsenic concentrations by ICP-MS. Results: Of the 18 households surveyed, 50% report that their main source of water ingestion is a combination of both tap water and bottled water. Preliminary data indicate that arsenic concentrations in the tap drinking water range from 2.84 to 21.32 mg/L, with a median concentration of 14.69 mg/L. Based on these data, we performed a preliminary quantitative risk assessment on the relative risk of lung and bladder cancer from exposure to arsenic in tap water. The analysis indicated the risk of males for lung and bladder cancers to be 8.27 and 3.71 in 10<sup>6</sup>, respectively in assuming consumption of tap water exclusively. The analysis also indicated the risk of females for lung and bladder cancers to be 6.48 and 1.02 in 10<sup>6</sup>, respectively in assuming consumption of tap water exclusively. These preliminary results exceed the EPA's acceptable carcinogenic risk limit of 1 in 10<sup>6</sup>. These are only preliminary results.

**003.01.10. An Evaluation of Speciated Plasma Arsenicals as Potential Biomarkers of Arsenic Exposure and Arsenic-Associated Diabetes in Individuals Living in Zimapan and Lagunera, Mexico**

Paige Bommarito

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**Abstract:** Background: Exposure to inorganic arsenic (iAs) remains a public health issue. Typically, three major forms of arsenic are measured in urine as biomarkers of iAs exposure, namely, iAs, and its metabolites, monomethylated arsenic (MMAs) and dimethylated arsenic (DMAs). This study is among the first to examine speciated plasma arsenicals as biomarkers of iAs exposure and iAs-associated disease, namely, diabetes mellitus (DM). Methods: Drinking water and plasma samples were collected from participants in the Zimapan and Lagunera cohort (N = 258). The relationships between drinking water iAs and plasma arsenicals were examined using both spearman correlations and multivariable linear regression models. Multivariable linear and logistic regression models were used to estimate the mean difference (95% CI) for the relationship between plasma arsenicals and diabetes indicators and the odds ratio (95% CI) for the relationship between plasma arsenicals and DM. Results: Plasma arsenicals were associated with drinking water iAs, with spearman correlation coefficients of 0.45 for P-MMAs, 0.48 for P-DMAs and 0.41 for total arsenic (P-tAs;  $p < 0.0001$ ). After adjusting for potential confounders, there were significant associations between log-transformed plasma arsenic and log-transformed diabetes indicators. Specifically, an interquartile range (IQR) increase in P-iAs was associated with fasting plasma insulin (0.089 (95% CI: 0.025, 0.153)), insulin resistance (HOMA-IR; 0.084 (95% CI: 0.017, 0.152)), and beta cell function (HOMA-B; 0.133 (95% CI: 0.007, 0.259)). Plasma arsenicals were not associated with the odds of DM. Conclusions: Speciated plasma arsenicals were associated with drinking water iAs, suggesting that they may serve as biomarkers of iAs exposure. Increases in fasting plasma insulin, HOMA-IR, and HOMA-B in the absence of changes in glycemia, indicate that plasma arsenic may be related to subclinical changes in pancreatic beta cell function that underlie DM development.

### **003.01.11. Co-Exposure to Methylmercury and Inorganic Arsenic in Baby Rice Cereals and Rice-Containing Teething Biscuits**

Sarah Rothenberg

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**Abstract:** Background: Rice is an important dietary source for methylmercury, a potent neurotoxin, and inorganic arsenic, a human carcinogen. Infants are often weaned onto rice-containing cereals. Rice baby cereals and other rice-containing products are a dietary source of inorganic arsenic; however, less is known concerning methylmercury. Methods: 48 boxes of baby foods were purchased in South Carolina (n=28), California (n=9), Ohio (n=6), New York (n=3), and Florida (n=2). Total mercury and methylmercury concentrations were measured in 36 rice baby cereals, eight rice teething biscuits, and four baby cereals manufactured with oats/wheat (n = 48). Concentrations of inorganic and organic arsenic species were determined in rice baby cereals and rice teething biscuits (n = 44/48), while total arsenic was determined in all products (n = 48). Results: All rice baby cereals and teething biscuits contained methylmercury, while inorganic arsenic concentrations in two brands of rice baby cereal (n = 12/36 boxes of rice cereal) exceeded 100 ng/g, the proposed action level from the U.S. Food and Drug Administration. Rice baby cereals and rice teething biscuits were on average 61 and 92 times higher in methylmercury, respectively, and 9.4 and 4.7 times higher in total arsenic, respectively, compared to wheat/oat baby cereals. For a 15-g serving of rice baby cereal, average methylmercury intake was 0.0092 µg/day (range: 0.0013-0.034 µg/day), while average inorganic arsenic intake was 1.3 µg/day (range: 0.37-2.3 µg/day). Conclusions: Results from this study suggest frequent ingestion of rice baby cereal and rice-containing teething biscuits will contribute to higher intake of both methylmercury and inorganic arsenic during the period when infant brains and bodies are rapidly developing. Studies concerning the cumulative impacts of methylmercury and inorganic arsenic on offspring development are warranted. Funding: NIH R21ES026412

### **O03.01.12. The Impact of Arsenic Exposure on Whole Blood DNA Methylation: An Epigenome-Wide Study of Bangladeshi Adults**

Kathryn Demanelis

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**Abstract:** Background: Arsenic exposure affects >200 million people worldwide, including ~56 million in Bangladesh. Arsenic exposure increases the risk of chronic disease, and one potential mechanism of arsenic toxicity is epigenetic dysregulation of DNA methylation. Objective: We assessed associations between arsenic exposure and genome-wide DNA methylation among 396 Bangladeshi adults participating in the Health Effects of Arsenic Longitudinal Study (HEALS), who were exposed by drinking naturally-contaminated well water. Methods: Methylation in whole blood DNA was measured at ~850,000 CpGs using the Illumina EPIC array. To assess associations between arsenic exposure and CpG methylation, we used multivariate linear regression models adjusted for covariates and surrogate variables (capturing unknown technical and biologic factors). We attempted replication and conducted a meta-analysis using an independent set of 400 exposed Bangladeshi adults with data on ~450,000 CpGs. Results: We identified nine CpGs associated with urine arsenic exposure (Bonferroni-corrected threshold  $p < 6.5 \times 10^{-8}$ ). Four of these CpGs annotated to the 450K array and all robustly replicated ( $p < 10^{-3}$ ). The top two CpGs annotated upstream of ABR (cg01912040, cg10003262). All urine arsenic-associated CpGs were also associated with arsenic measured in drinking water ( $p < 0.05$ ). Meta-analysis ( $n=796$ ) identified 33 urine arsenic-associated CpGs (Bonferroni-corrected threshold  $p < 1.3 \times 10^{-7}$ ). Among meta-analysis arsenic associated CpGs, gene-specific expression and methylation was associated for six CpGs ( $p < 0.05$ ) and associated CpGs annotated to three genes (EFNA1, SPSB1, SQSTM1) in the TNF $\alpha$  signaling via NF $\kappa$ B pathway (enrichment  $p = 7.7 \times 10^{-4}$ ). Conclusions: The robust associations between arsenic exposure and DNA methylation observed in this work suggest that epigenetic alterations may be important mediators in arsenic toxicity and could be further investigated as biomarkers of exposure and effect in exposed populations.

## 003.01D. Environmental Disasters and Climatic Events

### 003.01.13. The Impact of Hurricane Sandy on Pregnancy Complications in Eight Affected Counties of New York State

Jianpeng Xiao

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**Abstract:** Background: The frequency and intensity of natural disasters have increased during the past decades greatly. However, hurricane's effects on pregnancy remain not well known. Therefore, we investigated the short- and long-term impact of Hurricane Sandy on multiple pregnancy complications in eight affected counties in New York State. Methods: Using a time-series analysis (Poisson regression model), we assessed the percent increase of emergency department (ED) visits for pregnancy complications during Hurricane Sandy month (10/29/2012-11/27/2012) and 12 months following Hurricane Sandy period in the eight affected counties in southern New York State, compared to non-Sandy period using the 2005-2014 hospital discharge data, controlling for time trend, temperature, and air pollution. Results: ED visits for overall pregnancy complications increased 6.3% (95% confidence interval (CI): 2.2%, 10.5%) during the Sandy month. Especially, the ED visits increased significantly for threatened abortion (9.9%), threatened labor (10.1%), early onset delivery (115.9%), renal disease (73.2%), and diabetes (42.3%). The ED visits of spontaneous abortion, hypertension, mental health, genitourinary tract infections, and cardiovascular diseases did not increase significantly during the Sandy month. We also found that ED visits of mental health have increased gradually after Sandy, and peaked eight months later, with visits increasing 33.2%. Hypertension and renal disease also elevated 7-8 months after the hurricane period. Conclusions: Our findings suggest that Hurricane Sandy immediately affected pregnancy outcome, and remained for nearly a year. These findings have implications for decision-makers and pregnant women, given the increase in extreme weather.

### **O03.01.14. Volatile Organic Compounds and Pulmonary Function in Children: 1, 3, and 5 Years after the Hebei Spirit Oil Spill**

Hae-Kwan Cheong

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**Abstract:** Background: Nearby citizens were exposed to large volumes of volatile organic compounds (VOCs) for four days after the Hebei Spirit oil spill. Objectives: To investigate the cross-sectional and longitudinal relationships between initial exposure to VOCs in children and loss of pulmonary function 1, 3, and 5 years after the exposure event. Methods: Cumulative ambient VOC concentrations over the four days immediately after the spill, including benzene, toluene, ethylbenzene, xylene, and total VOCs (TVOCs), were measured with a modeling technique. The forced expiratory volume in 1 s (FEV1) of 224 children was assessed by spirometry at 1, 3, and 5 years after the spill. Multiple linear regression and linear mixed models were used to evaluate the associations, with adjustment for smoking. Results: The levels of VOC exposure represented, in order of volume, were as follows: xylene (mean: 11.2 mg/m<sup>3</sup>/4 d), toluene (10.1), ethylbenzene (6.2), and benzene (2.3). Percent of predicted FEV1 had significantly decreased after 1 (100.7), 3 (96.3), and 5 years (94.6). In a cross-sectional design, toluene, ethylbenzene, xylene, and TVOCs were significantly associated with percent of predicted FEV1 after 1 and 3 years, and ethylbenzene, xylene, and TVOCs were marginally significantly associated with percent of predicted FEV1 after 5 years. In a longitudinal design, benzene, toluene, ethylbenzene, xylene, and TVOCs were significantly associated with percent of predicted FEV1. Conclusions: Exposure to oil-derived VOCs resulted in loss of pulmonary function among children. These declines were persistent and did not reverse during the 5 years following the oil spill.

### **003.01.15. Tropical Storms and Associated Risk to All-Cause, Accidental, Cardiovascular, and Respiratory Mortality in 78 United States Communities, 1988-2005**

Meilin Yan

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Abstract: While risks of accidental deaths from tropical storms (e.g., drowning, carbon monoxide poisoning) have been well-documented, much less is known about risks for more common causes of mortality (e.g., cardiovascular, respiratory). Here, we conducted the first multi-year, multi-state epidemiological study to estimate the relative risks (RRs) of community-wide allcause, cardiovascular, respiratory, and accidental mortality associated with tropical storm exposure in the United States (US). To measure storm exposure, we used five hazard-related metrics-distance to storm track; cumulative rainfall; maximum sustained wind speed; flooding; and tornadoes. For each exposure metric, we modeled the association between community-level storm exposure and daily death counts in 78 large eastern US communities, 1988-2005, using a matched analysis of storm-exposed days versus similar unexposed days. We assessed risks for a window from two days before to seven days after the storm's closest approach. Over the study period, 92 Atlantic Basin tropical storms were considered based on US landfall or near-approach, with 70 communities exposed to at least one storm. Under windbased exposure metrics, we found substantially elevated risk for all mortality outcomes considered, with highest risk typically on the day the storm was closest. Based on windexposure, overall RRs of mortality during the full storm exposure window were 1.90 (95% CI: 1.58-2.29), 161.41 (61.62-422.80), 1.30 (0.97-1.76), 1.54 (0.70-3.39) for all-cause, accidental, cardiovascular, and respiratory mortality, respectively. These estimated associations may be dominated by extremely high risks during the few most severe storms (e.g., Andrew [1992], Katrina [2005]), a hypothesis we continue to explore. Our results suggest that very severe tropical storm exposures can have important mortality impacts beyond direct accidental deaths, including potentially important risks for cardiovascular and respiratory mortality.

### **003.01.16. Deepwater Horizon Oil Spill Exposures and Neurobehavioral Function in GuLF STUDY Participants**

#### Arbor Quist

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**Abstract:** Background: The 2010 Deepwater Horizon (DWH) oil spill released over 5 million barrels of crude oil and exposed tens of thousands of clean-up workers to hydrocarbons and other harmful chemicals. Some hydrocarbons, such as toluene and xylene, have been found to have acute adverse effects on the central nervous system. However, no studies have examined the association between oil spill exposures and human neurobehavioral function. Methods: To examine how maximum total hydrocarbon (THC) exposure and various job classes are associated with neurobehavioral function, we used data from the GuLF STUDY (Gulf Long-term Follow-up Study), a large cohort of adults who worked on the DWH clean-up and response. THC exposure was estimated from a job-exposure matrix that linked air measurement data to self-reported job data. Participants were categorized into 6 job classes based on their job with the likely highest exposure. Several neurobehavioral outcomes were assessed at clinical exams 4-6 years after the spill with the Behavioral Assessment and Research System (BARS). We conducted multivariable linear regression of the relationships between maximum THC level and job classes with 15 neurobehavioral outcomes, stratified by smoking. Results: Never smokers performed better than current smokers on 12 of the 15 neurobehavioral outcomes. We observed significant associations between maximum THC level and decreased neurobehavioral performance for attention, response speed, and visual memory among never smokers, but no associations were observed among former or current smokers. By job class, never smokers who worked near the wellhead had higher THC exposure and lower neurobehavioral performance, especially in complex functions and memory, compared to administrative workers with low exposure. Conclusion: Oil spill exposure may be associated with impaired neurobehavioral function, especially memory and attention, but this effect appears to be limited to never smokers.

## S03.01A. Assessing Manganese Exposure in Pediatric Populations across the Globe

### S03.01.01. Pediatric Manganese Exposure and Neurocognition in Eastern Ohio

Erin Haynes

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Abstract: Manganese (Mn) is both an essential element and neurotoxicant. Two communities in eastern Ohio have the two of the highest ambient Mn concentrations in the nation. Our goal is to address the communities' primary research question: "Does Mn affect cognitive development of children?" Children ages 7-9 were enrolled in the Communities Actively Researching Exposure Study (CARES) from Marietta, Cambridge, and East Liverpool, Ohio. CARES has been conducted using community-based participatory research principles. We conducted neurocognitive assessment (child IQ). Blood was analyzed for Mn and lead (Pb); hair were analyzed for Mn, and serum was analyzed for cotinine, a measure of second hand tobacco smoke. We used penalized splines to assess potential non-linear associations between biological measures and child IQ scores, followed by multivariable regression models with categorical variables based on quartiles of the distribution for biological measures. Both low and high Mn concentrations in blood and hair were negatively associated with child IQ scores. There was a negative association between hair Mn and child IQ in East Liverpool children. Serum cotinine was also negatively associated with child cognitive function. Community engagement has enhanced the research process and the translation of study findings for these communities.

### **S03.01.02. Manganese in Multiple Biomarkers and Neurodevelopment among Adolescents Residing near Ferro-Alloy Industry**

Birgit Claus Henn

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**Abstract:** Introduction: Growing epidemiologic evidence suggests that environmental exposure to manganese (Mn) in childhood is associated with neurobehavioral decrements. However, substantial gaps remain in understanding Mn health risks among adolescents and in relation to varying biomarkers and timing of exposure. Methods: As part of the Public Health Impact of Manganese Exposure (PHIME) study, we measured Mn in blood, hair, nails, saliva, and urine collected from 10-14 year old Italian children (N~720) living near ferromanganese industry. Mn was also measured in deciduous teeth to represent prenatal, postnatal, and early childhood exposure periods. Neurobehavioral assessments, conducted concurrent with biological sample collection, included the Wechsler Intelligence Scale for Children, Conners Behavior Rating Scale, and California Verbal Learning Test. Multivariable models evaluated associations between each Mn biomarker and neurobehavior. Weighted quantile sum regression was used to estimate associations of a weighted cumulative Mn index and to identify the biomarker with the largest contribution to neurobehavior score. Results: We observed inverse associations between childhood Mn with cognition (e.g., saliva and verbal IQ,  $\beta=-1.4$ ,  $p=0.004$ ) and memory (saliva and short recall,  $\beta=-0.3$ ,  $p=0.001$ ). In contrast, early life Mn (teeth) was associated with improved scores of cognition (digit span backward,  $\beta=0.4$ ,  $p=0.05$ ), behavior (teacher-reported inattention,  $\beta=-0.07$ ,  $p=0.04$ ), and memory (sum of intrusions,  $\beta=-1.8$ ,  $p=0.03$ ). The weighted cumulative Mn index, which included blood, hair, nail, saliva and urine Mn, was associated with worse performance on all three neurobehavioral assessments (verbal IQ,  $\beta=-4.0$ ,  $p=0.001$ ; parent-reported inattention,  $\beta=0.05$ ,  $p=0.01$ ); saliva was the largest contributor to most associations. Conclusions: These results suggest a complex relationship between Mn and neurobehavior, whereby associations may differ by biomarker and timing of exposure.

### **S03.01.03. Prenatal Manganese and Behavioral Problems in 5-Year Old Children from the Infants' Environmental Health (ISA) Study**

Berna Van Wendel de Joode

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**Abstract:** Background: Results from cross-sectional studies have shown excess manganese (Mn) may adversely affect children's neurodevelopment. However, data from prospective studies are limited. We examined whether prenatal manganese was associated with behavioral problems in children from the 'Infants' Environmental Health (ISA)' birth cohort study in Costa Rica, who live near banana plantations aerially sprayed with mancozeb, a Mn-containing fungicide. Methods: We interviewed mothers from 5-year old children (mean 5.7 ± 0.4 years) (n=292) about children's behavior during the last two months using the Child Behavior Checklist (CBCL). We measured Mn concentrations in maternal blood (MnB) and hair (MnH) samples collected 1-2 times during pregnancy, and calculated mean MnB and mean MnH concentrations. We analyzed internal consistency of CBCL and only analyzed scales with Cronbach-alfa >0.7. We examined linear and nonlinear relationships for log10-MnH and MnB concentrations and CBCL scales (Internalizing, Externalizing, Aggressive, Withdrawn) in separate models. We adjusted models for children's age at assessment, parity, HOME score, maternal education and maternal depression. We also revised effect modification by child sex. Results: Median (P25-P75) mean MnB and mean MnH during pregnancy were 24.0 µg/L (20.3-28.3) and 1.6 µg/g (0.8-3.3), respectively. Higher MnB concentrations were associated with more internalizing problems for girls ( $\beta=0.21$  95%CI: -0.02, 0.43) but not for boys ( $\beta=-0.02$  95%CI: -0.25, 0.21). MnB was not associated with other CBCL scales. We observed null associations for log10-MnH, and did not find evidence for non-linear relationships for MnB or MnH. Conclusions: Further studies, which include maternal and cord blood concentrations, as well as other essential elements, such as iron, are needed to understand whether maternal excess Mn during pregnancy contributes to behavioral problems in young children. Effects of excess Mn may be different for boys and girls.

### **S03.01.04. Prenatal and Early Postnatal Dentine Mn, Zn and Pb and Childhood Behavior**

Megan Horton

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**Abstract:** Background: Metal exposure alters neurodevelopmental outcomes; little is known about critical windows of susceptibility when exposure exerts the strongest effect. Objective: To examine associations between prenatal and early postnatal manganese (Mn), zinc (Zn) and lead (Pb) and childhood behavior. Methods: 153 subjects enrolled in a Mexico City birth cohort study provided deciduous teeth. We estimated weekly prenatal and postnatal dentine Mn, Zn and Pb concentrations in teeth using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICPMS) and measured behavior at ages 6-16 years using the Behavior Assessment System for Children, 2nd edition (BASC-2). We used distributed lag models and lagged weighted quantile sum regression to identify the role of individual and mixed metals on behavioral symptoms controlling for maternal education and gestational age. Results: Prenatal dentine Mn appears protective against behavioral problems, specifically hyperactivity and attention. Postnatal dentine Mn is associated with increased internalizing problems, specifically anxiety. At 6 months (mo), a 1-unit (unit = 1SD of log concentration) increase in Mn associated with a 0.18-unit (unit = 1SD of BASC-2 score) and 0.25-unit increase in the BASC-2 anxiety score, respectively. Postnatal Pb is associated with higher anxiety symptoms. At 12 mo, a 1-unit increase in Pb is associated with a 0.4-unit increase in anxiety. Examined as a mixture, we observe two windows of susceptibility to increased anxious symptoms: The first window (0-8 mo) is driven by Mn, the second window (8-12 mo) is driven by the mixture and dominated by Pb. A 1-unit increase in the mixture is associated with a 0.7-unit increase in SD of anxiety score. Conclusions: Prenatal dentine Mn may be protective, while postnatal Mn may increase risk for adverse behaviors. In combination, Mn, Zn and Pb may have an adverse impact on behavior.

S03.01B. Environmental Exposures and Breast Cancer across the Life-Course: Interdisciplinary Collaborations to Stimulate New Research Approaches, Improve Exposure Assessment during Critical Windows, and Accelerate the Translation of Research Findings into Disease

**S03.01.05. Study Design Considerations when Measuring Exposure Biomarkers of Non-Persistent Endocrine Disruptors in Epidemiologic Studies of Chronic Diseases Including Breast Cancer**

Susan Pinney

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Abstract: Endocrine disrupting chemicals are believed to increase risk of breast cancer. Exposure to EDCs is challenging to study with environmental biomarkers because they often have short half-lives and their exposure source may be linked to personal products used only during certain seasons, days, or certain times of the day. Designing studies incorporating the exposure biomarkers of these chemicals requires many critical decisions including consideration of the limit of detection (LOD) and quality assurance measures. The toxicokinetics and toxicodynamics of these chemicals likely vary by age and therefore, correlations of the different biomarkers available in urine vs. serum may also vary during the different windows of exposure. Benefits versus costs (both financial and non-financial) of repeated measurements over time need to be considered. Other exposure assessment and study design challenges include the content of the consent form, the biomedia to use, the time of sample collection, and laboratory selection. Protocols for sample collection and processing should consider feasibility within the overall study program, acceptability to the study participants, and especially elimination of potential sources of sample contamination. The effort to maintain a complete biospecimen inventory, and to track distribution of biospecimens, is substantial but absolutely necessary. This presentation will review these challenges and provide helpful suggestions for meeting them in design of epidemiologic studies examining exposure to EDCs with periodic use and short half-lives.

### **S03.01.06. Using Breast Density as an Intermediate Biomarker of Environmental Influence on Breast Cancer Risk**

Celia Byrne

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Abstract: Analyzing intermediate biomarkers of environmental exposures allows for detection of effects many years prior to disease onset. Mammographic density differences identify environmental factors of breast cancer risk even 5, 10, or 15 or more years prior to the onset of breast cancer. Compared to having low levels, women with higher levels of mammographic breast density have 4 to 6-fold increased risk of developing breast cancer. Identifying biological effects closer to the time of exposure allows for early prevention and/or intervention efforts. Mammographic breast density is not static throughout a woman's life. Most studies of mammographic density and breast cancer involved women older than 40, when the prevalence of mammography use and breast cancer incidence increases. As women go through the menopausal transition breast density declines but the rate of decline differs among women and serves as risk indicator. Recent studies using non-radiologic techniques examined breast tissue density in girls and younger women indicating that breast density serves as a biomarker of environmental exposures throughout the life-course. Examining the cumulative impact of endocrine disrupting chemicals (EDC) on breast density will clarify the EDC' breast cancer risk impact. Recent studies demonstrated that breast cancer risk increased, for women whose breast density increased when taking exogenous hormones, and conversely risk declined, for women whose breast density declined when taking selective estrogen receptor modulating treatments. Change in breast density mediated the effects of these hormonal treatments. This presentation highlights the benefits and concerns with interim biomarkers of risk in environmental studies of long latency diseases using the merits of breast density as a marker of EDC' effect on breast cancer risk as an example.

### **S03.01.07. Exploring Environmental Chemicals and Risk of Breast Cancer during the Menopausal Transition**

Susan Neuhausen

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Abstract: Teasing out the biologic mechanisms of endocrine-disrupting chemicals (EDCs) in epidemiologic studies is complicated given their heterogeneity, and assessing the effects of exposures in vitro assays and in vivo animal studies may not reflect what happens in human populations. Therefore, using a transdisciplinary approach with a population-based epidemiologic study, in vitro assays, and in vivo mouse models, offers a targeted opportunity to evaluate the role of EDCs in promoting breast cancer during the menopausal transition. We are specifically investigating the effects of three polybrominated diphenyl ethers (BDE-47, BDE-100, and BDE-153). Using blood samples collected during the menopausal transition from women in the prospective California Teachers Study (CTS) cohort, we are assessing the effects of PBDE levels on the epigenome through miRNA and global and gene methylation assays, on total estrogenic activity, and on risk of developing breast cancer. In in vitro experiments in breast cell lines, we are measuring the effects of PBDEs at a range of levels, including at the CTS serum levels, to assess their effects on the activity of the estrogen and progesterone receptors and aromatase, as well as on the epigenome, transcriptome, and cell proliferation. Initial results suggest that BDE-47 acts as a mild ER- $\alpha$  agonist and BDE-100 and BDE-153 act as weak antagonists. In in vivo mouse models, we are testing whether combined effects of PBDEs at the levels seen in serum of the CTS samples cause mammary gland lesions. We first are studying ovariectomized mice, which have minimal estrogenic activity in their bodies, and then will use an ovarian-failure mouse model to represent the menopausal transition. Definitive changes in uterus weight and gene expression profiles have been observed in mice following 1-week feeding of PBDE-containing diet.

### **S03.01.08. Environmental Chemicals and Postpubertal Breast Composition in a Cohort of Girls from Chile: Results from a Pharmacokinetics Study of Zeranol**

Vincent Bessonneau

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Abstract: As part of the NIEHS Breast Cancer and the Environment Research Program (BCERP), we are investigating associations between several endocrine disrupting chemicals (EDCs), including zeranol (Zer) and its metabolites, and breast density, hormones levels, and pubertal timing in a cohort of 400 girls in Santiago, Chile. Zeranol is a non-steroidal agent with potent estrogenic activity and is widely used as a growth promoter for cattle. It is also a fungal component found on grains. Parallel investigation of zeranol is being conducted in female rats exposed by oral gavage from weaning to post-natal day (PND) 42, and effects are being evaluated on mammary gland development and tumor susceptibility. This presentation will highlight the relation between urine and blood levels of Zer and its metabolites in a subset of 25 girls from a Chilean cohort. These relations between urine and blood levels in the cohort subset will be used to estimate blood levels in girls in the full cohort where Zer will be assessed in urine samples. We will also compare the blood and urine levels measured in girls with blood levels measured in rodents dosed with Zer at levels intended to mimic human exposure. Animal experiments can complement human epidemiology, providing information about mechanisms that cannot be accessed for study in humans. Pharmacokinetic studies can aid translation from animals to human health as well as from inexpensive, non-invasive urine samples to blood.

## S03.01C. Health Earth: Planetary Health Affects Everyone's Health

### S03.01.09. The Impact of Climate Change on Displacements of Population

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**Abstract:** Background: As climate change and its impacts become more evident through more frequent and extreme weather events, the most vulnerable populations and nations will suffer the most, and manifest through ever growing waves of migration in search of a better life. Method: Data will gathered on the Middle East as an example and a unique case study to understand this impact of climate change as a major determinant of health. Results: The Middle East conflicts and related migration result from a more complex accumulation of factors than simply attributing them to climate change. The heat waves, water scarcity, political instability, and desert storms are factors linked to global warming and planetary health that is going to impact the most vulnerable in societies of the Middle East. Migration of refugees through and from this region will continue to be a problem for the rest of the world. This will also be discussed in relation to current and future scenarios of climate change. The lack of public discussion and the low priority by governments regarding mitigation of climate change are some of the tasks that can be addressed at the international level to raise awareness of the consequences of climate change. Conclusion: Climate change is a manifestation of the planet's deteriorating health and in turn will be impacting the health of vulnerable populations in volatile regions such as the Middle East where multiple factors are creating the worst consequences of climate change.

### **S03.01.10. Holistic Effects of Climate Change on the Culture, Wellbeing and Health of the Saami, the Only Indigenous People in Europe**

Jouni Jaakkola

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**Abstract:** Background: Climate change will affect all populations, but particularly those living in northern latitudes where the predicted environmental changes are the most dramatic. The Saami are indigenous people living in northern Europe. Their traditional livelihoods are reindeer herding, fishing, gathering, hunting and handicrafts and their way of life is based on sustainable use of natural resources and living within nature. Ironically, this sustainable traditional way of life is threatened by changing environmental conditions linked to climate change. This presentation elaborates the effects of climate change, which are likely to be holistic, influencing culture, wellbeing and health. Methods: We present a multidisciplinary theoretical framework and empirical evidence based on a systematic literature search. Results: There is evidence from the Saami communities that the possibilities to practice Saami way of life and traditional livelihoods have already become weaker in Nordic Countries due to environmental, financial, legislative and societal pressures. Some of these pressures are linked to the emerging climate change. These changes in way of life have cultural, mental and social implications to Saami communities. There is evidence a major contributor to mental illness and associated conditions among indigenous populations is chronic psychosocial stress linked to rapid economic development and social transformations over the past half-century and this development is expected to accelerate due to climate change. Health and well-being of Saami community is therefore a serious concern in a changing climate. Conclusions: In order to Saami people to maintain their traditional way of life and identity, the effects of climate change on Saami people have to be identified and monitored. Adaptation to climate change requires information on the regional and long-term effects of climate change on the environment, health and well-being.

### **S03.01.11. How Development Choices Could Alter the Capacity of Health Systems**

Kristie Ebi

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**Abstract:** Background: Individual and collective choices will determine the pattern of demographic, socioeconomic, and technologic changes that will, in turn, affect the transitioning to a more resilient and sustainable world, including the burden of climate-sensitive health outcomes. Methods: Using a set of socioeconomic development trajectories, the Shared Socioeconomic Pathways (SSPs), along with the World Health Organization's Operational Framework for Building Climate Resilient Health Systems, we extend existing narratives to illustrate how aspects of health systems are likely to change over this century, and the implications of these trends for population health. Five narratives describe worlds with varying degrees of challenges to adaptation and mitigation. Results: Very different health system capacities and burdens of climate-sensitive health outcomes will likely arise under different development pathways, with substantial implications for population health. Transitioning to a more resilient and sustainable world to prepare for and manage the effects of climate change is likely to result in strengthened capacity to manage impacts that do arise and to better health outcomes overall. Continued significant fossil fuel use will likely result in high burdens of preventable conditions, such as undernutrition, malaria, and diarrheal diseases, coupled with reduced capacity to manage these challenges. The magnitude and pattern of health burdens and capacity of health systems will vary under other development pathways. Further research should examine how health systems are coping with health and climate change challenges, and the information, tools, and resources need to increase the capacity to manage future climate change-related health risks.

### **S03.01.12. Revisiting the Earth Charter and Our Ethical Obligations to Planetary Health**

Colin Soskolne

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**Abstract:** Background: Values and principles for global norms are urgently needed to incentivize individual and collective corrective action for transitioning humankind from its current unsustainable global trajectory. The Earth Charter (EC) provides such a set of values and ethical principles. **Methods:** Empirical observations of existing global-scale trends in all that sustains life are considered for seeking a solution to the current trajectory where humankind, embedded in the ecosphere, is destined to collapse. Comparative assessments of attempts to implement the EC in the few regions of the world with the foresight to do so, provide hopeful case studies demonstrating positive changes toward sustainability. **Results:** Observations since 2000, when the EC was formally adopted, show that its adoption remains far from complete. Further observations demonstrate that all indicators of sustainability, instead of improving, are worsening. In this presentation, the significance of the EC's values and principles are shown in different contexts. Case studies reveal how the EC is being incorporated into governance in Mexico, and from the City Government of São Paulo, Brazil, and in universities in Spain, Greece, and Florida, USA. These examples demonstrate the EC's utility, certainly as an educational instrument. Its implementation in a few parts of the world provides examples demonstrating that its integration into the fabric of life is attainable. **Conclusions:** The EC is a tool for aligning values and ethical guidance in our personal lives, as well as in all socio-economic organization and governance, if a sustainable path for humanity is to be achieved. If accomplished on a grand scale, the human enterprise would immediately shift from its current trajectory toward the collapse of life as we know it, to a path of sustainability. The role of environmental epidemiology in evaluating the potential of the EC to limit impacts from upstream determinants of health warrants consideration.

## S03.01D. Healthy Schools: Understanding Indoor Environmental Quality, Occupant Health, and Academic Performance

### **S03.01.13. Assess School Environmental Effects on Occupants' Health and Evaluate Environmental Policies' Impacts**

Shao Lin

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**Abstract:** Background: Over half of schools surveyed in the U.S. have reported at least one environmental issue. To date, few studies have assessed private school environment, how school exposures affected occupants, and environmental policies' impacts on children's health. Thus, we evaluated private school environment; assessed if school environment affects occupants' health; and examined if environmental policies reduced pollution and childhood asthma. Methods: We administered surveys to superintendents of NYS private and public schools to obtain their perception and concerns of the school environment. Working with NYS Teacher Union, we conducted a statewide survey among public school teachers to assess if school indoor air quality (IAQ) affected teachers' health. In addition, we also evaluated the impact of EPA NOx policy on childhood asthma. Results/Conclusion: We found that 92% of private schools reported not having an established IAQ program, 31% perceived IAQ in their school as poor; 69% claimed there were visible signs of moisture damage; and 61% are in close proximity to highway and/or train tracks. The teacher survey showed that experiencing  $\geq 1$  symptom was significantly associated with dust, dust reservoirs, paint odors, mold, and moldy odors (PR ranged from 1.65 - 3.67). Poor air conditioner use was significantly associated with poor test scores in children. Evaluating EPA's NOx Policy on respiratory diseases among children in NYS, we found the mean daily ozone concentrations significantly declined statewide and in 5 out of 8 regions following the NOx reduction policy. The adjusted respiratory hospitalizations also significantly declined statewide following the policy after controlling for temporal trends. We conclude that private schools have many environmental problems and school IAQ significantly affected occupants' health. Environmental policies may have positive impact on reducing air pollution and asthma burden.

### **S03.01.14. School Operations Reporting and Student Academic Achievement**

Jenny Apriesnig

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Abstract: Understanding the factors that influence student learning outcomes is critically important to school administrators tasked with designing and staffing schools. Considerable research has assessed differences in student achievement by focusing on teacher quality, class size, teacher turnover, and student teacher ratio. While discerning the impact that teachers have on students is of obvious importance, there is also interest in understanding how the built environment influences student achievement. Here, we assess how the environmental characteristics of schools influence student achievement. We use a panel dataset from a suburban Denver school district of approximately 41,000 students to understand how school characteristics impact student achievement. Specifically, we evaluate the relationship between school environmental characteristics and standardized test scores. The school environmental characteristics include thermal comfort, acoustics, visual quality, indoor air quality, and Energy Star rating, which are specific to each of the 54 schools in the district. By observing students that transition between schools as they move from elementary to middle schools and from middle to high schools, we evaluate how the differing school environmental characteristics impacts achievement. When controlling for other school characteristics and student demographics, we find a school's Energy Star score, acoustics, and indoor air quality have a positive relationship with student test scores, while thermal comfort consistently has a negative relationship with test scores. The positive impact of the Energy Star score is particularly robust to differences in how the achievement model is specified. Given this, we evaluate the specific components of the Energy Star score. Overall, the results highlight the importance of evaluating both the environmental impacts and the impacts on student achievement associated with the construction of energy efficient schools.

### **S03.01.15. School Environment, Indoor Air Quality, Student Performance and Health**

Meredith McCormack

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**Abstract:** School environment is a key exposure for school age children. Understanding the link between school community, school building, and indoor environment characteristics and student performance and health provides insight as to means of improving student performance and health. A large school renovation program in the mid-Atlantic region provided an opportunity to study the relationship between indoor air quality and other school environmental factors and student performance, school climate, and health. Building inspection data and community-level data were linked to student administrative data from an urban school district in the mid-Atlantic region. Facility conditions and school neighbourhood characteristics were associated with student math and reading performance with chronic absences. In a subset of schools planned for renovation, school building factors and outdoor environmental characteristics were associated with indoor air quality. Indoor air pollutants, including PM<sub>2.5</sub>, NO<sub>2</sub>, CO<sub>2</sub>, exceeded WHO or ASHRAE guideline recommendations for a portion of the time monitored. Twenty percent of the daily average PM<sub>2.5</sub> and 25% of the hourly average NO<sub>2</sub> concentrations exceeded corresponding WHO guidelines for indoor air. Seasonal variability was statistically significant for indoor NO<sub>2</sub> and CO<sub>2</sub> concentrations, with higher exposures in fall and winter, suggesting a role for improvements in ventilation. Temperatures were frequently (~2/3 of school day) outside of recommended ranges. These findings provide evidence that community and school environments are associated with academic achievement and attendance, suggesting that opportunities to improve school conditions may translate to improvement in school performance for students.

### **S03.01.16. Environmental Quality, Health and Learning in Conventional and High Performance School Buildings**

Stuart Batterman

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**Abstract:** Aims: Schools are critical indoor environments that can affect the health, comfort and performance of children and teachers alike. We discuss lessons learned in an intervention study of schools and highlight issues related to ventilation, filtration and outcomes assessments. Methods: We compare indoor environmental quality (IEQ) parameters in a 37 recently constructed or renovated elementary school buildings, balanced between high performance and conventional buildings located in the US Midwest. We then compare results of interventions designed to increase ventilation and particle filtration (from MERV8 to MERV13) using a case-crossover design and repeated measures involving 550 students and 2 schools. We report on attendance, cardiopulmonary fitness using the Progressive Aerobic Cardiovascular Endurance Run (PACER) test, and student learning. We also characterize IEQ parameters in four classrooms in each school, using multiday measurements. The buildings varied in design, HVAC system, size, and other factors. Only 22% of classrooms met recommended minimum ventilation rates. Occupancy in many classrooms was highly variable, thus, the use of carbon dioxide (CO<sub>2</sub>) concentrations as a tracer for determining ventilation rates should use the transient mass balance method. It was sometimes difficult to detect significant differences in air change rates when ventilation rates were increased, and improving filtration did not always lower particulate matter concentrations. We show that increasing ventilation with low efficiency filters can increase PM<sub>2.5</sub> levels. Students and teachers had positive experiences with the PACER test. Conclusion: Intervention studies have strengths and allow investigation of both IEQ and student performance. Interventions must be carefully selected to ensure meaningful exposure contrasts and yield meaningful epidemiological evidence.

## S03.01E. Multidisciplinary Approaches for Traffic Related Burdens through Route Specific Exposures and Dose to Noise, Air Pollution and Quality of Life: Making Better Measurements

### S03.01.17. Understanding Traffic-Related Air Pollution Exposures through Mobile Monitoring

Joshua Apte

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Abstract: Human exposures to air pollution can vary sharply in space and time. Carefully designed mobile sampling campaigns are now able to reveal patterns of long-term ambient air pollution concentrations at fine scales ( $\ll 100$  m). Here, we report on a campaign where two specially equipped Google Street View cars mapped spatial patterns of air quality in the San Francisco Bay Area between May 2015 and December 2017. Cars were outfitted with reference-grade instruments to measure NO, NO<sub>2</sub>, black carbon (BC) and ultrafine particle number count at  $\sim 1$  Hz. During a 30-month campaign, measurements occurred on most weekdays during daytime hours, resulting in a large dataset:  $\sim 10$ M samples collected during  $> 4000$  h, encompassing 100k km of driving. First, we sampled every road 20-50 $\times$  within three neighborhoods ( $\sim 30$  km<sup>2</sup>) in Oakland, CA, during the first year of measurements. We found persistent fine-scale variability in pollution exists within many neighborhoods. In some neighborhoods, prominent  $\sim 50$ -200 m sized hotspots of elevated primary pollutants were ubiquitous, with pollutant levels varying by 5-8 $\times$  within many city blocks. Next, during 1.5 years of follow-up measurements, we mapped pollutant concentrations in rural, suburban, and dense urban neighborhoods throughout the SF Bay Area. These measurements reveal how within-neighborhood pollution structure is overlaid on top of regional spatial gradients in air quality. Repeated measurements over the 2.5-year period demonstrate persistent spatial variability over time. Patterns of NO, NO<sub>2</sub> and BC in Oakland had high correlation ( $r^2 > 0.85$ ) between the first and second years of measurement. Short-term measurement periods ( $\sim 1$ -2 months) were sufficient to reproduce overall spatial patterns, albeit with  $\pm 30\%$  bias in mean concentrations relative to annual-average conditions. This presentation summarizes how routine mobile air pollution monitoring reveals new information about spatial variability in population exposure to air pollution.

### **S03.01.18. Wearable Sensors for Geolocation, Physical Activity and Air Pollution: Challenges and Opportunities**

Juan Orjuela

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**Abstract:** Introduction: Procedures for measuring continuous data on geolocation, physical activity (PA), and air pollution (AP) have improved greatly in recent years but storing, cleaning and analyzing these can be challenging. Data collected from mobile phones is useful to estimate for example geolocation, transport mode, and PA levels, but more data does not always lead to better outcomes. Method: We use the results from three different studies (AirMAP, CAVA and PASTA) to illustrate the challenges in managing datasets for AP exposure estimates, and comment on their strengths and weaknesses. The datasets vary greatly: AirMAP was part of the Telecom Italia Big Data challenge 2015 which combined aggregated data from cellular towers (~8 million users) in grid cells of varying sizes (10 - 300m) in seven Italian cities; in CAVA, GPS and accelerometer readings derived from a smartphone app were collected from 180 participants in Barcelona; PASTA collected detailed geolocation, PA, and AP exposure data from 120 free-living individuals in three European cities using separate monitors for each in a relatively burdensome and resource intensive approach. For each study, daily exposures estimated as a function of daily activity patterns were compared to estimates based on home location. Results: Processing large and complex datasets to identify people's daily activities and account for microenvironmental concentrations in estimating personal exposures is still challenging. Mode for example is key in daily pollutant intake (modal choice may result in differences of up to 20%) but identifying it is a difficult task. AirMAP data suggests that home-based exposures overestimate daily activity-based exposures (by 6%), contrary to the other two studies (~18%). Conclusion: The comparison gives insights into difficulties of collecting, processing and interpreting data from current state of the art wearable devices, and into opportunities for large scale ubiquitous sensing.

### **S03.01.19. A High Resolution Spatiotemporal Model for In-Vehicle Black Carbon Exposure: First Application on Epidemiological Cohorts**

Luc Dekoninck

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Abstract: Several studies have shown that a significant amount of daily air pollution exposure is inhaled during trips. In this study, car drivers assessed their own black carbon exposure under real-life conditions (223 h of data from 2013). The spatiotemporal exposure of the car drivers is modeled using a data science approach. In-vehicle exposure is highly dynamical and is strongly related to the local traffic dynamics. An extensive set of potential covariates was used to model the in-vehicle black carbon exposure with a temporal resolution of 10 s. Traffic was retrieved directly from traffic databases and indirectly by attributing the trips through a noise map as an alternative proxy for traffic. Modeling by generalized additive models (GAM) shows non-linear effects for meteorology and diurnal traffic patterns. A fitted diurnal pattern explains indirectly the complex diurnal variability of the exposure due to the non-linear interaction between traffic density and distance to the preceding vehicles. An external validation, based on a dataset gathered in 2010-2011, quantifies recent exposure reductions inside cars at 33% (mean) and 50% (median). The EU Euro 5 PM emission standard (in force since 2009) explains the largest part of the discrepancy between the measurement campaign in 2013 and the validation dataset. An in-depth analysis of the model covariates and modelling approach will be discussed. The requirements of the epidemiological databases to enable health evaluations will be summarized. A first real-life application of the model on an epidemiological cohort will be introduced.

### **S03.01.20. Merging Mobile Measurements, Traffic Emissions Models, and Land Use Regression Towards Real-Time Estimation of Traffic-Related Air Pollution**

Steve Hankey

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**Abstract:** Background: Current Land Use Regression (LUR) modeling approaches lack the spatiotemporal precision needed to match people's time-activity patterns for exposure assessment. We developed spatiotemporal LUR models of Particle Number (PN) and Black Carbon (BC) concentrations using two pieces of information: (1) mobile monitoring and (2) on-road emissions estimates from the INTEGRATION microscopic traffic simulation model which tracks vehicle movements, fuel consumption, and emissions every second. Methods: We employed mobile monitoring to collect ~120 hours of PN and BC measurements in Blacksburg, VA. Data collection was stratified by time of day (~10 hours of monitoring for each hour during 7am-7pm). We calibrated the INTEGRATION traffic emissions model to estimate hourly PN and BC emissions (100m spatial scale). We combined these datasets, along with traditional LUR covariates (e.g., land use variables), for model building. We developed and compared three types of models: (1) daytime average models that pool all mobile measurements, (2) hourly models (i.e., single model for each hour of day) and (3) spatiotemporal models (single model incorporating hour of day as a predictor). Results: Model fit for the daytime average models (adj-R2 for PN [BC]: 0.72 [0.66]) were comparable to models developed using fixed-site measurements. The hourly models (i.e., 12 separate models) had modest model fit (mean PN [BC] adj-R2: 0.52 [0.36]). The spatiotemporal models had the poorest model fit among model-types (adj-R2 for PN [BC]: 0.46 [0.27]). Results for the temporally resolved models were comparable to other mobile monitoring campaigns that attempted to model long-term averages suggesting it is possible to develop models with both spatial and temporal precision for real-time dissemination. Conclusions: Our approach to model traffic-related air pollution allows for matching the temporal and spatial resolution of people's time-activity patterns towards improved exposure assessment.

S03.01F. NASA Applications for Public Health and Air Quality Models and the Translation of Research Into Policy and Other Decision Making

**S03.01.21. NASA Applications for Public Health and Air Quality Models and Decisions Using Earth Observation Systems**

John Haynes

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Abstract: As part of NASA approach and methodology they have used Earth Observation Systems and Applications for Public Health and Air Quality Models to provide a method for bridging gaps of environmental, spatial, and temporal data for tracking disease. Health providers and researchers need environmental data to study and understand the geographic, environmental, and meteorological differences in disease. Satellite remote sensing of the environment offers a unique vantage point that can fill in the gaps of environmental, spatial, and temporal data for tracking disease. This presentation will demonstrate the need for collaborations between multi-disciplinary research groups to develop the full potential of utilizing Earth Observations in studying health. Satellite earth observations present a unique vantage point of the earth's environment from space, which offers a wealth of health applications for the imaginative investigator. The presentation is directly related to Earth Observing systems and Global Health Surveillance and will present research results of the remote sensing environmental observations of earth and health applications, which can contribute to the public health and air quality research. As part of NASA approach and methodology they have used Earth Observation Systems and Applications for Public Health and Air Quality Models to provide a method for bridging gaps of environmental, spatial, and temporal data for tracking disease. This presentation how weather will provide an overview of projects dealing with infectious and water borne diseases and how environmental variables effect human health. This presentation will provide a venue where the results of both research and practice using satellite earth observations to study weather and it's role in public health research.

### **S03.01.22. Searching Panacea for Cholera**

Antarpreet Jutla

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Abstract: Cholera is a medically treatable disease, however, outbreak of this infection still pose a major public health threat across globe. The causative agent of the disease, *Vibrio cholerae*, cannot be eradicated from the environment, primarily due its ability to survive and adapt to a host of climatic conditions. Data on disease prevalence and infectious pathogens is sparingly collected/available in region(s) where climatic variability and extreme natural events intersect with population vulnerability (such as lack of access to water and sanitation infrastructure). Therefore, traditional time series modeling approach of calibration and validation of a model is generally inadequate. Hence, prediction of diarrheal infections (such as cholera, *Shigella* etc) remain a challenge even though disease causing pathogens are strongly associated with modalities of regional climate and weather system. Here we present an algorithm that integrates satellite derived data on several hydroclimatic and ecological processes into a framework that can determine high resolution cholera risk on global scales. Cholera outbreaks can be classified in three forms- epidemic (sudden or seasonal outbreaks), endemic (recurrence and persistence of the disease for several consecutive years) and mixed-mode endemic (combination of certain epidemic and endemic conditions) with significant spatial and temporal heterogeneity. Using data from multiple satellites (AVHRR, TRMM, GPM, MODIS, VIIRS, GRACE), we will show examples from Haiti, Yemen, Nepal and several other regions where our algorithm has been successful in capturing risk of outbreak of infection in human population. A spatial model validation algorithm will also be presented that has capabilities to self-calibrate as new hydroclimatic and disease data become available. We will also discuss how information on socio-economic status and human behavior influence public health decisions.

**S03.01.23. Advancing Extreme Heat Epidemiology Using Remotely Sensed Earth Observations: Generating a Long-Term Historical Time-Series of Daily Heat Metrics at the Community-Level**

Ambarish Vaidyanathan

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Abstract: Epidemiologic studies exploring health impacts of extreme heat have relied on data from weather stations, which are limited in geographic scope. For this analysis, our objectives were to: (1) conduct a health assessment to evaluate differences in heat-attributable fractions (AFs) of mortality generated using temperature data from weather stations and earth observation based meteorological models; and (2) generate extreme heat metrics for CDC's National Environmental Public Health Tracking Network (Tracking Network). A daily time-series of heat metrics were created from weather stations and the North American Land Data Assimilation System Phase 2 (NLDAS) model. A county-specific time-series analysis was conducted for 2001-2015 using both station- and model-based data. The county-specific mortality risk information was pooled in a meta-analytic framework to characterize regional AFs for both station- and model-based data. Region-specific AFs were then compared to identify degrees of overlap and discrepancies between results generated using the two data sources. There is a high degree of overlap between region-specific AFs generated using temperature data from weather stations and the NLDAS model. AFs generated using NLDAS data provide robust inferences on region-specific differences in heat-mortality relationships as they include far more communities and not just those with weather stations. Extreme heat metrics from the NLDAS model were therefore generated for years 1979-2016, for every county and census tract in the coterminous U.S. Comprehensive spatiotemporal data coverage is a valuable attribute in public health. Disseminating model-based extreme heat metrics on CDC's Tracking Network could facilitate exposure ascertainment and health risk assessments at finer geographic scales.

### **S03.01.24. An Operational System for Surveillance and Ecological Forecasting of West Nile Virus Outbreaks**

Michael Wimberly

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Abstract: Mosquito-borne disease surveillance has traditionally focused on tracking human cases along with the abundance and infection status of mosquito vectors. Vector and host population dynamics are also sensitive to climatic factors, including temperature fluctuations and the availability of surface water for mosquito breeding. There is a potential to strengthen surveillance and predict future outbreaks by monitoring environmental risk factors using broad-scale sensor networks that include earth-observing satellites. The South Dakota Mosquito Information System (SDMIS) project combines entomological surveillance with gridded meteorological data from NASA's North American Land Data Assimilation System (NLDAS) to generate weekly risk maps for West Nile virus (WNV) in the north-central United States. Critical components include a mosquito infection model that smooths the noisy infection rate and compensates for unbalanced sampling, and a human infection model that combines entomological risk estimates with lagged effects of meteorological variables from the North American Land Data Assimilation System (NLDAS). Two types of forecasts are generated: long-term forecasts of statewide risk extending through the entire WNV season, and short-term forecasts of the geographic pattern of WNV risk in the upcoming week. Model forecasts are connected to public health actions through decision support matrices that link predicted risk levels to a set of phased responses. SDMIS accurately predicted higher-than-normal WNV transmission in 2016 and lower-than-normal transmission in 2017. Our experiences highlight several important lessons that can inform future efforts at disease early warning. These include the value of integrating climatic models with recent observations of infection, the importance of automated workflows to facilitate timely integration of multiple data streams, and the need to link forecasts with specific public health responses.

## S03.01G. Novel Methods for Assessing Exposure to Temperature and its Health Effects

### S03.01.25. Does Temperature Variability Modify Heat Impacts on Mortality? A Multi-City Multi-Country Study

Yuming Guo

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**Abstract:** Background: There is increasing evidence that both temperature extremes and variability are risk factors for mortality. However, it is still unknown whether temperature variability is a modifier of the temperature-mortality relationship. Methods: We collected daily mortality and mean temperature from 511 communities in 28 countries/regions across the world. Temperature variability was calculated by the standard deviation of daily mean temperature at lags of 0-3 days. Community-specific time series model was used to examine the linear effect of heat (lag 0-3 days) on mortality in summer, while controlled for impacts of temperature variability and modelled their interaction on mortality. Random-effect meta-analysis was applied to summarise the city-specific associations. Results: The preliminary results of this study show that the effects of temperature on mortality were slightly higher when not controlling for temperature variability. For the interaction analysis, the lower the temperature variability, the higher the heat effects on mortality. However, the interaction effect was not statistically significant. At international level, each 5 celsius degree increase of temperature was associated with 2.8% (95% CI: 2.3%, 3.3%) increase of mortality in the first quartile of temperature variability, while there was 2.3% (95% CI: 1.8%, 2.8%) increase of mortality in the fourth quartile of temperature variability. The trends were similar for all cities/countries/regions, although there was significant variation in the heat impacts. Conclusion: The findings suggest no apparent need to control for temperature variability when modelling the heat effects on mortality. On behalf of the MCC Collaborative Research Network.

### **S03.01.26. Information on Exposure History Is Needed to Fully Understand Heat Effects on Elderly Mortality**

Hyun-Joo Bae

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**Abstract:** Background: Temperature change and extreme weather events caused by climate change are known risk factors to human health. Many studies have been conducted to understand the effects of climate change on adverse health outcomes. Objectives: We aimed to understand the relationship between elderly mortality and temperature anomaly using the Temperature Deviation Index (TDI), which considers exposure history. Methods: We assessed the effects of TDI on mortality in Korea from 1992 to 2015. The TDI was defined as the target day's temperature abnormality compared to previous 25 years' apparent temperature (AT). The relationship between the TDI and elderly mortality was examined by generalized linear modeling with Poisson distribution. Results: Most regions showed positive linear associations, and the associations ranged from 0.1% to 0.5% increase per unit increase of the TDI. Our analysis showed that increase in TDI was significantly associated with increase in elderly mortality in Korea. Conclusions: We suggest a positive and significant association between elderly mortality and temperature deviation index (TDI) an indicator representing abnormality of temperature using exposure history.

### **S03.01.27. Local Extreme Point Temperature and Mortality in Korea**

Youn-Hee Lim

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**Abstract:** Background: Climate change has been issued because of its extreme patterns of temperature. We aimed to capture relatively extreme temperature within certain periods of time and associate it with health outcomes. Methods: We developed a novel method, Local extreme point temperature (LEP), to compare concurrent day's temperature with those in previous 3 days and determined whether it is a maximum value of temperature within the periods. We investigated the association between the LEP and cause-specific mortality (total, non-accidental, cardiovascular, ischemic heart disease, cerebrovascular, ischemic stroke, and haemorrhagic stroke) in 7 cities in Korea during 1992-2016. Using a time-series design, we estimated the percent change in mortality associated with the LEP after controlling for relevant covariates. Results: Total mortality increased by 1.8% (95% confidence intervals (CI), 1.3%, 2.3%) on days with the LEP compared to non-LEP days. The estimates were greater for cardiovascular mortality, 2.6% (95% CI, 1.1%, 4.2%), and ischemic stroke mortality, 3.0% (95% CI, 0.4%, 5.7%). Conclusion: Local extreme point temperature can be considered as an independent risk factor for mortality.

### **S03.01.28. Temperature Variability and Mortality in Urban and Rural China: An Application of Spatiotemporal Index**

Kejia Hu

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**Abstract:** Temperature variability (TV) is a potential trigger for death in urban areas, but there is little evidence of this in rural areas. In addition, a typical TV index only considers the temporal changes of temperature and ignores its spatial variability, which should be considered due to the effects of human mobility. In this study, we collected daily data on fine-gridded hourly temperatures and >2 million deaths that occurred in Zhejiang province, China from 2009 to 2015. A spatiotemporal TV index was developed by calculating the standard deviation of the hourly temperatures from multi-site records. A three-stage analysis was performed to estimate the mortality risks and mortality burdens of TV. Stratified analyses were performed by cause-specific mortality, urban/rural district, age and gender. Significant associations were found between TV and all types of targeted diseases, age groups, and genders. Percentage increase in mortality associated with a 1 °C increase in TV at 0-7 exposure days were found to be higher for rural dwellers than urban dwellers in the warm season [for all-cause mortality, 2.07% (95% CI: 1.49%, 2.64%) vs. 1.16% (95%CI: 0.70%, 1.62%)]. The elderly (aged 65+ years) and females were more sensitive to TV than young people and males, respectively. Additionally, we found that spatiotemporal TV produced higher mortality risks and larger attributable mortality fractions than typical TV indices. In summary, TV is an independent health risk factor. In China, rural areas generally suffer greater TV-related mortality risks than urban areas in the warm season. Overlooking spatial TV potentially underestimates the true effect of TV on mortality. These findings have important implications for developing area-, cause-, and group-specific adaptation strategies and emergency planning to reduce TV-related mortality.

## S03.01H. Science and Action for Safer Materials and Products

### **S03.01.29. Anticipating Impacts of Chemicals and Materials: Science for Context-Based Decisions**

Elaine Cohen Hubal

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**Abstract:** The landscape of consumer products is rapidly changing as novel chemicals and materials are designed and incorporated to enhance performance. Science and tools are needed to evaluate exposure and safety of chemicals and materials in the broader context of how these are used in our society. Scientifically sound approaches are required to increase the pace at which relevant information can be obtained and integrated into decision-making. A systems-, or context, based strategy for identifying and evaluating safer alternatives as well as ensuring that decisions minimize health risks and environmental impacts sustainably is proposed. Information and tools that are being developed to extend understanding of features and function to predict impacts under real-world conditions are highlighted. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the US EPA.

### **S03.01.30. Policy Drivers for Safer Chemistry: Lessons Learned from a Review of Substitution Policies and Program Support Tools**

Molly Jacobs

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Abstract: Effectively mitigating the impact of toxic chemicals on human health and the environment requires not only taking regulatory action on chemicals of concern, but also supporting the informed transition to safer, alternative chemicals and technologies. Increased drivers for informed chemical substitution have led to a rapid evolution of substitution provisions within policies, as well as significant growth in alternatives assessment frameworks and methods. Nonetheless, most of these efforts are in their early stages. As part of an initiative to provide substitution policy and programmatic recommendations to government authorities, this project reviewed international substitution policies efforts and the availability of substitution assessment tools. Over 30 international regulatory and non-regulatory policies and programs that include informative substitution provisions were identified and analysed. In addition, four categories of alternatives assessment tools were reviewed, including chemical screening, comparative chemical hazard evaluation, economic and technical assessment, and frameworks for alternatives assessment. This presentation will describe notable findings from this review and elevate 5 primary elements that should be incorporated into the design and implementation of future substitution policies and associated support programs.

### **S03.01.31. Exposure Considerations Under California's Safer Consumer Product Regulations**

Meredith Williams

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Abstract: The Safer Consumer Products (SCP) program is being implemented to reduce toxic chemicals in the products consumers buy and use. California's ground-breaking regulations identify specific products that contain potentially harmful chemicals and ask manufacturers to innovate and find safer alternatives. When deciding which products to prioritize, the department bases its decisions on chemical exposure potential and hazard potential. When selecting safer product designs or formulations, manufacturer decisions are also informed by the exposure pathways associated with those alternatives considered. This presentation describes the role of exposure science in informing California's policy and will discuss how tools such as conceptual models, dust studies, and near-field exposure models have been applied in SCP decision making. The presentation will highlight opportunities to address exposure-related information gaps to advance the search for alternatives.

### **S03.01.32. New Approaches to Prioritize Chemicals of Concern in Children's Products**

Marissa Smith

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Abstract: Predictive toxicology tools can be useful in prioritizing chemicals of concern found in children's consumer products. Traditional approaches for characterizing toxicity are laborious and do not cover the breadth of new and existing chemicals found in children's products. Recent regulations limiting the concentration of some toxic chemicals in children's consumer products have spurred the development of alternatives. However, it is challenging for traditional toxicity assessment approaches to keep up with the dynamic introduction of alternative chemicals. This presentation focuses on new predictive toxicology and chemical prioritization tools to help better characterize toxicity and exposure factors needed to make decisions that promote child health and development. Examples of chemical groups that will be discussed include engineered nanomaterials and phthalates. In vitro and in silico assessments can add valuable information to toxicity assessments, when appropriately interpreted. Examples of details needed for appropriate interpretation of in vitro assay results include cytotoxicity, dosimetry, chemical properties and binding patterns. Understanding what information is necessary to integrate new predictive toxicology tools and databases for prioritization of chemicals in children's consumer products within traditional toxicity assessments is important for identifying safer alternatives and promoting safe and sustainable children's products. In addition to available approaches we will also future directions and needs for chemical prioritization. This project is supported by the Environmental Protection Agency (FP-91779601-0, RD 83573801, RD 83451401) and the National Institute of Environmental Health Sciences (5P01ES009601).

## S03.01I. Translating Scientific Evidence About near Source Traffic Pollution Into Policy and Practice

### S03.01.37. Using Research on Traffic Pollution to Influence Policy and Practice

Doug Brugge

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**Abstract:** Introduction: Community Assessment of Freeway Exposure and Health (CAFEH) is a series of community-based participatory research and translational projects in the Boston, MA area. CAFEH has used our air pollution exposure and epidemiology research to translate our findings and the broader literature into policy and practice at the neighborhood, municipal, metropolitan area and state level. Methods: To assess the impact of CAFEH, we conducted key informant interviews with people to whom we provided technical assistance (n=13). We asked about 1) their connection to CAFEH, 2) the ways in which CAFEH influenced their decision making, 3) the feasibility and acceptability of integrating protective measures against traffic pollution and 4) how they were using and disseminating knowledge they gained. Responses were recorded by note taking. Two researchers coded responses thematically by question and met to reconcile codes after which content analysis was applied. Results: Overall respondents had a favorable opinion of CAFEH. The most common impacts described were related to construction practices and the type of filtration used. Developers reported shifting building practices to use filtration above the industry standard. Policy makers described developing legislative proposals designed to reduce traffic-related exposures and attributed them directly to their work with CAFEH. Municipal planners said that working with CAFEH changed that way they think about community design so that they thought more about the health impacts of urban planning decisions. Overall, participants reported that what they learned continued to influence their decision-making for up to several years. It was also reported that engagement with CAFEH strengthened connections to the university. Conclusion: The CAFEH approach to CBPR has had modest, but real impact by actively translating our research and knowledge into policy and practice. Future efforts should attempt to expand the reach of these impacts.

### **S03.01.38. Global Goods Movement, Land-Use and Environmental Justice in Los Angeles, CA**

Jill Johnston

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Abstract: The Trade Health and Environment (THE) Impact Project integrates science-based information and community-based action to ensure that reducing health, environmental, and community impacts of international trade becomes central to the transportation planning and urban design process in Los Angeles, California. Our academic- environmental justice partnership aims to shift the debate about transportation and health to elevate community voices in policymaking, while ensuring that advocates and policymakers use the latest science to inform their efforts. We will describe impacts of this action-oriented research, data collection and education, including regional and county-level policies on siting of schools near transportation corridors, adding high quality air filters to schools, using zero-emission technologies along goods movement corridors and halting the development of a massive diesel rail yard. In addition, there is a growing conflict between low-income housing needs and hazards of building along freeways. On-going efforts are underway to use the research to inform best practices and building codes at the City level if development is allowed very near freeways. Finally, we will share on-going efforts to re-envision urban design in urban environmental justice communities to secure healthy places for parks/green space, active transportation, and community gardens in cumulatively burdened neighborhoods.

### **S03.01.39. A Health Impact Assessment Study of the Barcelona 'superblock' Model**

Natalie Mueller

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**Abstract:** Background: Car-centric city designs of previous decades have resulted in sedentary lifestyles, high levels of environmental pollution and the disappearance of natural outdoor environments. The Barcelona 'superblock' model is a promising land-use strategy with the aim to reduce motor traffic while promoting active transport and returning public space to the citizens in order to promote social cohesion and healthy urban living. Methods: A health impact assessment (HIA) is carried out for 1,306,583 Barcelona residents  $\geq 20$  years assessing the health consequences of the projected superblock implementation with respect to expected changes in physical activity levels, air pollution, noise, local temperatures and access to green spaces. Preventable premature mortality, gains in life expectancy and economic impacts related to the superblock model are estimated. Results: With the implementation of the superblock model local traffic is expected to be reduced by 13%. Accordingly, current annual mean NO<sub>2</sub> levels of 46.2  $\mu\text{g}/\text{m}^3$  were estimated to be reducible to 35.2  $\mu\text{g}/\text{m}^3$  resulting in 506 preventable premature deaths (95% CI: 258-744) annually. Current annual mean Lden(Road) noise levels of 51.7 dB were estimated to be reducible to 48.3 dB resulting in 148 preventable premature deaths (95% CI: 75-223) annually. Temperature and green space analyses as well as evaluations of changes in life expectancy and economic impacts are still ongoing. Conclusions: The Barcelona superblock model is an encouraging land-use intervention with the aim to overcome contemporary burdensome motor traffic in cities and the associated physical inactivity crisis as well as environmental pollution burden. Associated health impacts are expected to make a case for the rapid implementation of this new urban model.

### **S03.01.40. Integrating Land Use and Transportation Advocacy with Environmental Health Science in Somerville MA U.S.A.**

Wig Zamore

*Wig Zamore<sup>1</sup>*

*1. Somerville Transportation Equity Partnership, Somerville, MA, United States.*

Abstract: Over several decades, activists in Somerville have worked to secure greater live work and green space balance, and healthier transportation alternatives, while also seeking to protect neighborhood character. We are a diverse median income community, next to booming Cambridge and Boston, with 60 languages spoken in our high school and less than 2 acres of public green space per 1000 residents. Per square mile, Somerville has 20,000 residents, mostly renters, and the state's greatest shortage of jobs relative to residents, and intensity of highway and diesel rail pollution. We have drawn on a history of environmental injustice and sought to expand our expertise in district design, planning, economic balance, transportation decision processes, and environmental health. Progress has been achieved via interaction with developers and government, litigation when necessary, and environmental health awareness. We have had some successes. Assembly Square, a large urban riverfront district planned to be big box retail and parking lots, is now redeveloping as a transit-oriented mixed-use district, with expanded riverfront green space and enhanced pedestrian and bicycle connections. It includes a developer funded subway stop, the first built in MA in three decades. It is also home to many new mixed income residents and the headquarters of PARTNERS Health, the largest hospital-based life sciences research group in the US. We have also secured state and Federal commitments to two new light rail branches, nearly half constructed, and completion of a transformative regional bike and path network. These projects represent over \$2 billion in new healthy transportation assets. Finally, working with Tufts and other research universities, we have advanced understanding of transportation pollution and cardiovascular risk, as well as mitigation tactics. Nevertheless, further integration of health and environment into all design scales remains challenging and critically important.

## 003.02A. Air Pollution, Atherosclerosis, and Cardiovascular Disease

### 003.02.01. Long-Term Effects of Air Pollution on Ankle-Brachial Index

Siqi Zhang

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**Abstract:** Background: Ankle-brachial index (ABI) has been linked to the risk of cardiovascular events. However, the association between long-term exposure to air pollution and abnormal ABI has not been fully investigated. Methods: This cross-sectional study involved 4,544 participants from the KORA Study (2004-2008) in the region of Augsburg, Germany. Participants' residential annual mean concentrations of particulate matter and nitrogen dioxide were predicted with land-use regression models, and the traffic information was collected from geographic information systems. We applied multinomial logistic regression models to assess the effects of air pollution on the prevalence of low and high ABI, and quantile regression models to explore the non-monotonic relationship between air pollution and ABI. Results: Long-term exposure to particulate matter with an aerodynamic diameter  $\leq 10 \mu\text{m}$  (PM<sub>10</sub>) and  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) was significantly associated with the prevalence of low ABI (ABI < 0.9), with the respective odds ratios (ORs) of 1.78 (95%CI: 1.09-2.92) and 1.63 (95%CI: 1.03-2.58) for an increment from the 5th to the 95th percentile in concentration. For high ABI (ABI > 1.3), the association was significant for PM<sub>2.5</sub> absorbance (OR = 1.54, 95%CI: 1.07-2.24) and traffic load within 100 m of the residence (OR = 1.39, 95%CI: 1.04-1.86). Quantile regression analyses revealed similar results. Conclusions: Long-term exposure to particulate matter and traffic-related air pollution was associated with higher prevalence of low and high ABI, respectively, indicating the adverse effects of air pollution on atherosclerosis and arterial stiffness in lower extremities.

### **003.02.02. Traffic-Related Air Pollution and Carotid Atherosclerotic Plaque Burden and Progression in London, Ontario, Canada**

Markey Johnson

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**Abstract:** The association between fine particulate matter (PM<sub>2.5</sub>) and cardiovascular disease (CVD) has been convincingly demonstrated. However, the role of traffic related air pollutants (TRAP) on CVD is less clear. To better understand the potential impacts of TRAP on CVD, we examined associations between nitrogen dioxide (NO<sub>2</sub>), carotid atherosclerotic plaque, and cardiometabolic disorders associated with CVD. Analyses were conducted among 2227 adult patients (63±14 years; 50% women) from the Stroke Prevention and Atherosclerosis Research Centre in London, Ontario, Canada. Total plaque area and progression, cardiometabolic disorders, and residential locations were obtained from medical records. Plaque was measured using 2-dimensional ultrasound. Plaque area progression was defined as an increase of > 5 mm<sup>2</sup> from baseline measurement. Outdoor residential NO<sub>2</sub> concentrations were generated by a land-use regression model. Associations between NO<sub>2</sub>, carotid plaque, and cardiometabolic disorders were examined using multiple linear regression models adjusted for age, sex, smoking, and socioeconomic status. Mean outdoor residential NO<sub>2</sub> concentration was 5.4 ppb (range: 3.0 to 13.0 ppb). NO<sub>2</sub> was associated with increased carotid plaque area and there was a positive interaction between NO<sub>2</sub>, smoking, and plaque progression (p<0.05). NO<sub>2</sub> was also associated with cholesterol and triglycerides (p<0.05), and marginally associated with diabetes. Diabetes mediated the relationship between NO<sub>2</sub> and plaque (p<0.05). Our results demonstrate for the first time that even low levels of TRAP exposure may be linked to atherosclerosis, an association which may be partially attributable to pollution-induced diabetes. Our results suggest that reducing ambient concentrations in cities with NO<sub>2</sub> below current standards would result in additional health benefits; and given the billions of people exposed to traffic emissions, our study supports the global public health significance of air pollution reduction.

### **003.02.03. Air Pollution and Subclinical Atherosclerosis in a Peri-Urban Area in South India (CHAI-Project)**

Cathryn Tonne

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Abstract: Previous studies linking particulate air pollution with carotid intima-media thickness (CIMT), a subclinical marker of atherosclerosis and predictor of cardiovascular events, have been conducted in high-income countries, with low or moderate levels of air pollution. We investigated the effect of ambient PM<sub>2.5</sub> and biomass fuel use on CIMT in a population-based cohort in peri-urban South India. We estimated annual average PM<sub>2.5</sub> outdoor at residence using land-use regression. Biomass cooking fuel was self-reported. Our exposures of interest were the mean and maximum CIMT, measured using a standardized protocol in the right common carotid during the third follow-up (2010-2012) of the APCAPS cohort. We fit a linear-mixed model including ambient PM<sub>2.5</sub> and biomass fuel use adjusting for potential confounders, in the whole population and stratified by sex. Models incorporated a random intercept for village, and a fixed effect for village-average PM<sub>2.5</sub>. Among 3278 participants (48% females, mean age 38 y), the mean PM<sub>2.5</sub> was 32.7 [range 24.4 to 32.2] µg/m<sup>3</sup>, 60% used biomass as their primary fuel, and the mean CIMT was 0.83 mm. We observed a positive association between within-village variation in PM<sub>2.5</sub> and mean CIMT in the whole population (+9.0% [-1.6, 19.5] per 5 µg/m<sup>3</sup> PM<sub>2.5</sub>) and among males (+14.9% [1.2, 26.6]). The effect of biomass compared to clean fuel (gas or electricity) was more pronounced among females, particularly among those without a stove vented to the outside (+6.1% [1.4, 10.9]). The effect of PM<sub>2.5</sub> was mainly driven by sub-groups with higher cardiometabolic risk profile. Results were robust to sensitivity analyses. We observed a strong association between ambient PM<sub>2.5</sub> and CIMT in a population with high prevalence of cardiovascular risk factors and higher levels of ambient air pollution than in the previous literature. Both ambient and household air pollution appear to contribute independently to atherosclerosis in this population.

### 003.02.04. Air Pollution Exposure and Progression of Atherosclerosis in Different Vessel Beds

Frauke Hennig

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**Abstract:** Background: Air pollution (AP) is an important environmental risk factor and atherosclerosis-based cardiovascular diseases are the leading cause of death in the westernized world. Epidemiological studies on the association of AP with atherosclerosis are scarce and inconsistent across different subclinical markers. We investigated AP effects (PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>) on progression of multiple subclinical markers of atherosclerosis (carotid intima media thickness (cIMT) and coronary/thoracic aortic calcification (CAC/TAC)). Methods: We used 5-year follow-up data from the German Heinz Nixdorf Recall cohort study (4814 participants aged 45-75 years at baseline (t<sub>0</sub>: 2000-2003)). Residential long-term exposure to PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub> [µg/m<sup>3</sup>] was modelled via a chemistry transport model in 1x1km<sup>2</sup> grid cells. To harmonize progression of atherosclerosis among markers, progression was defined as any increase in side-specific cIMT (cIMTR, cIMTL [mm]) or CAC/TAC [Agatston score units] over 5 years. Using confounder-adjusted logistic regression, we calculated odds ratios (OR (95%-confidence intervals)) in the full sample, in participants with no (cIMT<sub>t0</sub><0.7mm, or CAC<sub>t0</sub>=0, TAC<sub>t0</sub>=0) or low (CAC<sub>t0</sub><10, TAC<sub>t0</sub><10) degree of subclinical atherosclerosis at baseline. Results: While no associations were observed in the full sample, AP was associated with progression in participants free of subclinical atherosclerosis at baseline, e.g. a 5 µg/m<sup>3</sup> increase in PM<sub>10</sub> yielded an OR of 1.7 (1.1, 2.6) for cIMTL, and 1.3 (1.0, 1.7) and 1.3 (0.9, 1.9) for incident CAC and TAC. For CAC<sub>t0</sub>/TAC<sub>t0</sub><10, estimated ORs were 1.2 (0.9, 1.4) for CAC, 1.1 (0.8, 1.3) for TAC. A 5 µg/m<sup>3</sup> increase in NO<sub>2</sub> yielded slightly weaker results, e.g. 1.3 (1.0, 1.6) for cIMTL. There was no evidence for progression in CIMTR with any investigated air pollutant. Conclusion: Results indicated air pollution effects on progression of atherosclerosis in three out of four vessel beds in participants with no degree of atherosclerosis at baseline.

### **003.02.05. Residential Ambient Particulate Air Pollution and Blood Pressure in Peri-Urban India**

Ariadna Curto Tirado

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**Abstract:** Long-term exposure to ambient fine particulate matter (PM<sub>2.5</sub>) has been linked to high blood pressure in high-income countries. However, it is unclear if these findings are generalizable to low- and middle-income countries, which may have higher PM<sub>2.5</sub> levels dominated by different and mixed sources. We examined cross-sectional associations between annual residential ambient PM<sub>2.5</sub> and black carbon (BC) levels with systolic blood pressure (SBP) and diastolic blood pressure (DBP) in adults living in a peri-urban area outside of Hyderabad, India. Blood pressure was measured in the right arm after 5 minutes of sitting rest using an oscillometric device. Annual averages of PM<sub>2.5</sub> and BC at residence were estimated using land-use regression models. Participants (N=5,531, 18-84 years, 54% men) lived in 2,296 households across 28 villages. We used nested linear mixed-effect models (households nested within villages) stratified by sex to estimate associations between within-village differences in PM<sub>2.5</sub> or BC and SBP and DBP. Annual average PM<sub>2.5</sub> was 32.8 µg/m<sup>3</sup> (SD=2.7) and BC was 2.5 µg/m<sup>3</sup> (SD=0.2). In women, SBP increased by 1.47 mm Hg (95%CI, 0.21 to 2.74) per 1 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> after adjusting for personal, household, and environmental confounders. Results were weaker and not statistically significant in men, for DBP, and for BC (in both men and women). Adjustment for cooking fuel did not change the results. Our study provides support for an association between ambient PM<sub>2.5</sub> and SBP in women, independently of the type of cooking fuel. Further research focusing on personal exposure and using longitudinal designs is needed to provide valuable insights into the relationship between particle exposure and blood pressure in populations exposed to relatively high ambient concentrations, such as those present across much of India.

### **O03.02.06. Personal Ozone Exposure, Blood Pressure and Vascular Endothelial Function: A Panel Study Based on Cytokines, DNA Methylation and Metabolomics**

Renjie Chen

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**Abstract:** Background: Epidemiological studies have reported inconsistent findings on the cardiovascular effects of exposure to ambient ozone. There is a lack of molecular epidemiological studies of ozone based on personal real-time monitoring. Objective: To explore the impacts of personal ozone exposure on blood pressure and vascular endothelial function. Methods: We conducted a longitudinal panel study with 4 follow-ups among 40 college students in Shanghai, China, during the warm period of 2016. We measured in real time personal ozone exposure levels and serum angiotensin-converting enzyme (ACE) and endothelin-1 (ET-1), locus-specific methylation of ACE and ET-1. We also used an untargeted metabolomic approach to systemically evaluate the vascular effects of ozone. We applied linear mixed-effects models to examine the effects of ozone on blood pressure (BP), ACE, ET-1, DNA methylation and metabolites. Results: An interquartile range (IQR, 47.58  $\mu\text{g}/\text{m}^3$ ) increase in 2 hours' ozone exposure was significantly associated with increments of 1.77mmHg in systolic BP and 1.69 mmHg in diastolic BP. Simultaneously, there were increases of 5.20% in ACE and 0.48% in ET-1. DNA methylation of the two cytokines decreased following ozone exposure. An IQR increase in ozone concentrations (0-8 h) was significantly associated with 0.20 % decrease in locus-average ACE methylation. The inverse association between ozone exposure and ET-1 methylation only occurred in one locus. Metabolomic analysis showed meaningful changes following ozone exposure in serum lipid metabolites in relation to vascular endothelial dysfunction. Conclusions: Our findings highlighted a potential mechanistic pathway linking acute ozone exposure to increased blood pressure and vascular endothelial dysfunction.

## 003.02B. Air Pollution, Fetal Growth, and Birth Outcomes

### **003.02.07. The Effects of Prenatal Exposure to PM<sub>2.5</sub> on Fetal Growth: Evidence from a Birth Cohort Study in China**

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**Abstract:** Objectives: We aimed to investigate the effects of PM<sub>2.5</sub> exposure on fetal growth, and further clarify the susceptible exposure window based on a birth cohort in China. Methods: Pregnant women who had their prenatal care in the first trimester were recruited in the obstetrical clinics, and were followed up till their delivery time. Their personal information was collected by questionnaire, and their clinical information was obtained through their medical records. Each participant's individual exposure to PM<sub>2.5</sub> during the pregnancy was assessed using an spatio-temporal modelling that integrated a land-use-regression model and individual activity pattern. Results: A total of 2,845 pregnant women were recruited in this study, with an average age of 31 years. The average PM<sub>2.5</sub> exposure during the entire pregnancy was 31.14µg/m<sup>3</sup>. The results of multiple linear regression analyses show that after adjustment for potential confounding factors each 10µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure during the first trimester was associated with 1.55cm decrease in crown heel length in the first trimester, and 0.17cm less in birth length. Each 10µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure during the second trimester was linked to decreases in head circumference, abdomen circumference, biparietal diameter and femur length by 2.38cm, 2.05cm, 0.90cm and 1.12cm, respectively. However, the PM<sub>2.5</sub> exposure during the third trimester was associated with increase in birth length by 0.16cm. Conclusions: Prenatal exposure to PM<sub>2.5</sub> may be an important risk factor of fetal growth. The first and second trimesters might be the sensitive exposure window. Our findings added new information, and extended our understanding of the risk factors of fetal growth. More studies are needed to explore the mechanisms of PM<sub>2.5</sub> affecting fetal growth

### **003.02.08. Spatiotemporal Variations of Maternal Exposures to Air Pollution and Risks of Adverse Birth Outcomes in Lanzhou, China**

Lan Jin

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**Abstract:** Previous studies indicated associations between air pollution and adverse birth outcomes, but results were inconclusive. Different exposure assessment methods might contribute to this apparent inconsistency. The objective of this study is to estimate maternal exposures to air pollution using exposure assessment methods with various spatiotemporal resolutions, and related risks of adverse birth outcomes in Lanzhou, China. The study population is 8087 singleton live births with maternal and work addresses in Lanzhou urban area. Exposures during entire pregnancy were estimated for PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub>, using land use regression (LUR) models or government monitoring data. Spatial exposure variables were developed: road densities, industrial areas near residence and proximity to major point sources. Logistic or linear regression models were used to investigate associations of maternal exposures with risks of congenital heart defect (CHD), preterm birth (PTB), low birth weight (LBW), or change in birth weight. Models were adjusted for maternal social economic status and risk factors. Risks were estimated for interquartile range increases of exposure variables. Clusters of adverse birth outcomes occurred in the west of the city, where major point sources were concentrated. Maternal exposures to PM<sub>10</sub> were significantly associated with increased CHD risks (OR: 2.23, 95% CI: 1.38, 3.58) and reduced birth weight (-21.1 g, 95% CI: -38.5, -3.6 g). Proximity to major point sources marginally elevated LBW risks (OR: 0.82, 95% CI: 0.67, 1.00). Effect estimates based on LUR-modeled exposures were more certain than those based on government monitors. Maternal exposures to particles were associated with increased risks of adverse birth outcomes in Lanzhou, which has major point sources. Studies investigating air pollution exposures and related health risks at high spatiotemporal resolutions is valuable for disentangling health effects of different air pollutants or pollution sources.

### **003.02.09. The Effect of Maternal PM2.5 Exposure on the Risk Pre-Term Births: Results from Project ELEFANT**

Liqiong Guo

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**Abstract: Background/Aims:** Exposure to fine particulate matter of <2.5mm (PM2.5) during pregnancy is associated with adverse birth outcomes, including miscarriage and birth defects. There is a pressing public health need to better understand the impact of such exposures. Here, we analysed the effects of pre-pregnancy and in utero PM2.5 exposure upon the risk of pre-term births by its timing and intensity. **Methods:** We used data from 10,306 live births within Project ELEFANT, a multi-cohort study based in Tianjin, China. Data on pre-term births (n=220) was recorded by obstetricians. Hourly air pollution measured by local ambient monitoring stations was averaged for the exposure period and used to calculate the number of days individuals were exposed to PM2.5 levels over 50, 100, 150, 200, 250 and 300µg/m<sup>3</sup> by month/trimester. We used generalized additive models to represent the non-linear relationship between outcome and spatio-temporal varying PM2.5 exposure. Models were adjusted for maternal age, education & occupation, neonate gender, region, paternal smoking, gravidity, parity, and mean temperature & dew point of the exposure period. **Results:** Risk of pre-term birth increased with higher frequency of extreme PM2.5 exposure in the final month of pregnancy. Relative risks (RR) ranged from 1.04 (95% CI: 1.00-1.07) with increased exposure to >50µg/m<sup>3</sup> PM2.5 to 1.53 (1.32-1.79) with exposures to >250µg/m<sup>3</sup>. Higher risk was also observed with increased exposure to >250µg/m<sup>3</sup> in the second- (1.19, 1.02-1.40) and third-last months of pregnancy (1.47, 1.30-1.67). Further, the RR of pre-term birth was 1.67 (1.40-1.99), 1.65 (1.32-2.07) and 1.57 (1.27-1.94) with increased exposure to >250µg/m<sup>3</sup> PM2.5 in the first-, second- and third-months before pregnancy respectively. **Conclusions:** Our findings reveal that the level and timing of PM2.5 exposure are critical in establishing the risk of pre-term birth. Further work is required to elucidate their associations with birthweight and birth defects.

### **003.02.10. Exposure-Lag-Response Association between Prenatal Ambient Air Pollution Exposure and Preterm Birth in Guangzhou, China**

Qiong Wang

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Abstract: Prenatal trimester-specific air pollution exposure has been associated with preterm birth (PTB), however, little is known about the effects of gestational week specific exposure on PTB and critical exposure windows are still unclear. Using data from the Guangzhou Birth Registry including 506,210 singleton live births between January 2015 and July 2017, we assessed the susceptible exposure windows during pregnancy at weekly level. Daily average concentrations of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, and O<sub>3</sub> from 11 monitoring stations were used to estimate district-specific exposures for each participant based on residential addresses during pregnancy. Distributed lag models (DLMs) were applied to estimate the association between weekly-specific maternal air pollutant exposures and PTB, after controlling for temperature, seasonality, and individual covariates. Hazards ratios (HRs) and 95% confidential intervals (95%CIs) were calculated for an interquartile range (IQR) increase in air pollutants during the study period. Multi-pollutant models were also performed. PTB risk was significantly associated with PM<sub>2.5</sub> exposure during the 17th to 25th gestational week, with the strongest effect in the 22nd gestational week (IQR=27.0 ug/m<sup>3</sup>; HR=1.04, 95%CI:1.02-1.06). The significant exposure windows were 14th-30th gestational weeks for PM<sub>10</sub>, 9th-27th for NO<sub>2</sub>, and 19th-28th for O<sub>3</sub>, respectively. Corresponding peak associations were observed in the 25th gestational week for PM<sub>10</sub> (IQR=37.0 ug/m<sup>3</sup>; HR=1.04, 95%CI:1.02-1.05), in the 22nd for NO<sub>2</sub> (IQR=29.0 ug/m<sup>3</sup>; HR=1.03, 95%CI:1.02-1.05), and in the 24th for O<sub>3</sub> (IQR=90.0 ug/m<sup>3</sup>; HR=1.06, 95%CI:1.04-1.08). No significant association between pregnancy SO<sub>2</sub> exposure and PTB was observed. In multi-pollutant models, effects of each pollutant retained but were slightly reduced. Our results suggest critical air pollution exposure windows for PTB risk vary slightly among air pollutants, while the mid-gestation was similarly observed as a susceptible period.

### **O03.02.11. Exposure to PM2.5 and Risk of Pre-Term Birth: Applying Distributed Lag Non-Linear Models to Disentangle Complex Exposure-Lag-Response**

Andreas Neophytou

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**Abstract:** Evidence in the literature suggests an association between maternal exposure to air pollution during pregnancy and increased risk of pre-term birth. Assessing exposure effects occurring over the duration of pregnancy can be challenging, as timing, intensity and duration of exposure could all be biologically relevant. Cumulative exposure or trimester averages assume a constant lag-response over the duration of pregnancy or trimesters, respectively, and may not fully capture true relationships. In this study we applied distributed lag non-linear models (DLNM) within a survival analysis, in order to better examine the exposure-lag-response between average weekly PM2.5 exposure during gestation and risk of pre-term birth. We analyzed data from all live births with PM2.5 data on the week level (n=79,119) in Fresno County, California, from 2000 to 2006. We fit pooled generalized additive logistic models to approximate hazard ratios (HR), adjusting for gestational age, calendar time, temperature, mother's race/ethnicity, education, age and socioeconomic status. Our results indicate increased risk of pre-term birth associated with exposure during a lag-window of 0-20 weeks prior to the week at risk, with higher risk between lags 7-15. For the majority of cases the latter lag-window occurred within the second trimester of pregnancy. Non-linearity in the exposure-response was also observed with steeper relative increase in the hazard at lower ranges of the observed exposures. The HR for pre-term birth at 35 weeks of gestation corresponding to an increase from 13.6 µg/m<sup>3</sup> (the median of the observed exposures) to 18.6 µg/m<sup>3</sup>, for the duration of the second trimester of pregnancy was 1.45 (95%CI: 1.11,1.91). Our results suggest that both timing and intensity of exposure are contributing factors to the overall exposure-lag-response. The flexibility allowed by DLNMs could benefit studies of exposures accrued over the duration of pregnancy in relation to pregnancy related outcomes.

### **O03.02.12. Characterization of Maternal Mechanisms Relevant to Metal Exposure-Mediated Infant Birth Weight Outcomes in the MIREC Study**

Premkumari Kumarathasan

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Abstract: There is growing evidence on the association between prenatal metal exposures and adverse pregnancy outcomes. Heavy metals such as arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb) are considered as endocrine disrupting chemicals and elevated exposure to these metals during pregnancy is associated with adverse effects on maternal and infant health. Nevertheless, mechanistic understanding is required to establish biological plausibility of such associations. The objective of this study was to gain insight into metal exposure-related adverse birth outcomes by understanding maternal systemic changes at the molecular level. The Maternal-Infant Research on Environmental Chemicals (MIREC) study was employed for this purpose. Third trimester maternal plasma samples were analysed for target oxidative /nitrative stress markers (e.g 8-isoprostane, 3-nitrotyrosine) by competitive enzyme immunoassay and HPLC-Coularray as well as matrix metalloproteinases, a class of enzymes and other markers of inflammation (e.g. Cytokines, cellular adhesion molecules) were measured by affinity-based multiplex array and HPLC-Fluorescence detection methods. Pearson product moment correlations, chi-squared tests and multivariate models were used to analyse the associations among maternal blood metal (Cd, Hg, Pb, As, manganese Mn) levels, plasma biomarkers, physiological changes and birth weight. Our results revealed maternal metal exposure-specific responses ( $p < 0.05$ ) on markers of oxidative stress pathways (e.g 8-isoprostane) and matrix metalloproteinases (MMPs), in maternal circulation. Interestingly, statistically significant ( $p < 0.05$ ) correlations were seen between oxidative stress pathways, MMPs and other inflammatory mediators relevant to infant birth weight changes. Our findings imply that metal exposures potentially can mediate maternal oxidative stress pathways which can alter MMP profiles and associated inflammatory processes, thus adversely impacting on infant birth weights.

**O03.02.13. Benefits of Personal Modeling for Air Pollution Exposure Assessment**

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Abstract: There is a need to move from static (residential) to dynamic (personal) estimates to assess an individual's air pollution exposure. However, data is limited on the added value of dynamic exposure modeling versus estimates based on residential address commonly used in health studies. We built personal exposure estimates of particulate air pollution (PM<sub>2.5</sub> and soot; PM<sub>10</sub>) and compared it to personal measurements as well as residential ambient estimates. Forty two participants were monitored for 24 hours three non-consecutive times. Participants were equipped with a smartphone and a gravimetric sampler. Personal measurements of PM<sub>2.5</sub> and PM<sub>10</sub> were obtained with a microbalance of 1µg accuracy and a Smoke Stain Reflectometer, respectively. The dynamic model integrates: (i) smartphone time-resolved geo-location; (ii) time in micro-environments from a spatiotemporal map-matching algorithm; (iii) an outdoor/indoor penetration factor; (iv) land-use regression models for PM<sub>2.5</sub> and PM<sub>10</sub>; and (v) government monitoring stations. Residential estimates were computed combining home geo-location with land-use regression estimates adjusted temporally by the daily ratio of the closest monitoring station. A total of 123 measurements were obtained. The median and interquartile range of personal exposure measurements was 9 (7.6) µg/m<sup>3</sup> for PM<sub>2.5</sub> and 0.8 (0.7) 10<sup>-5</sup>/m for PM<sub>10</sub>. The agreement (Concordance Correlation Coefficient) between personal measures and personal and residential estimates were respectively 0.58 (0.45 - 0.69) and 0.43 (0.32 - 0.53) for PM<sub>2.5</sub>, and 0.55 (0.41 - 0.67) and 0.48 (0.35 - 0.59) for PM<sub>10</sub>. The dynamic model improves the concordance with personal measurements by 38% and 15% as compared to the static estimates of PM<sub>2.5</sub> and PM<sub>10</sub>, respectively. Applying dynamic models may provide a way forward to obtain more valid individual estimates of ambient air pollution exposure.

### **003.02.14. Field Experience with a Commercial Biometric Shirt for Measuring Minute Ventilation and Potential Inhaled Dose of Air Pollutants**

Steven Chillrud

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**Abstract:** Real-time estimates of volumetric minute ventilation (MV) can now be made through wearable sensors, allowing field studies to extend the personal exposure approach to more accurately account for impact of physical activity and calculation of the potential inhaled dose (PID) or intake of air pollutants. The Hexoskin biometric shirt includes sensors for all three proxy methods for estimating minute ventilation: dual band respiratory inductance plethysmography (RIP), heart rate (HR) and accelerometry (ACC). Laboratory validation of the sensors against a gold standard has been reported on previously. Here we will provide our experience in an ongoing field study of biking commuters who self-deploy the shirt and additional monitors for up to six 24 hour periods over a 3 week period. Data completeness from the biometric shirt sensors is high with only 6 out of 327 attempted sessions missing data (2%); within the obtained data, the percentage with valid data are 89% for the dual band RIP sensors, 80% for the HR monitor and 88% for the ACC. Poorly fitting shirts can impact the RIP or HR sensors (or both), with poor fits occurring more frequently on females. Failure of all three sensors simultaneously is rare allowing missing data to be filled in from other working sensors based on individual level comparisons. MV values during sleep appear anomalously low for a large fraction of participants (median 5.0 L/min, IQR 3.6 - 7.0 L/min) and 0.06% of RIP derived values appear above physiological reasonable values, leading to the use of replacement values. Final cleaned MV data derived from the shirt show a much wider range, both between subjects and within subjects, than the EPA reference values, suggesting exposure misclassification can occur if relying upon reference values for calculating PID.

### **O03.02.15. Assessment of Microenvironmental Exposures to Ultrafine Particles among Adolescent Schoolchildren**

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**Abstract:** Background: Assessing personal exposure to ultrafine particles (UFPs) is challenging due to multiple indoor and outdoor sources and high spatiotemporal variation. Our objective is to characterize personal UFP exposures experienced by adolescents enrolled in the Ecological Momentary Assessment and Personal Particle Exposure Study (EcoMAPPE). Methods: Participants (ages 13-17) complete a seven-day sampling period using a personal UFP monitor for 3 hours each day that simultaneously records GPS-based location at 1-second resolution. Measured UFP concentrations are assigned to microenvironments based on speed and distance from participant specified locations: schools (400m), homes (100m), and other (100m) locations. UFP concentrations measured outside these areas exhibiting speeds greater than 2 m/s are categorized as occurring while in transit. We define the percent contribution of each microenvironment to a participant's overall exposure as the summation of UFP concentration in a specific microenvironment divided by the summation of all recorded UFP concentrations. Lastly, we derive exposure-time ratios by dividing the percent contribution of each microenvironment by the percentage of time spent within each microenvironment. Results: Complete sampling and location data is available for 21 participants, representing 378.5 hours of UFP data. The overall median UFP concentration is lowest at home (4,500 particles/cm<sup>3</sup>), while school/other (5,990), and transit concentrations (7,960) are higher. Most UFP measurements are recorded at home (70%), followed by school/other locations (23%), and transit (7%). Participants experience median exposure-time ratios of 0.99 (Q1: 0.90; Q3: 1.04) at home, 0.82 (0.45; 1.21) at other locations, and 1.10 (0.62; 1.73) in transit. Conclusion: Despite the low percentage of time spent in transit, most participants experience UFP concentrations during transit that contribute more to their overall exposure in comparison to other microenvironments.

### **003.02.16. The Influence of Residential and Workday Population Mobility on Exposure to Air Pollution in the UK**

Stefan Reis

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Abstract: Traditional approaches of quantifying population-level exposure to air pollution assume that concentrations of air pollutants at the residential address of the study population are representative for overall exposure. This introduces potential bias in the quantification of human health effects. Our study combines new UK Census data comprising information on workday population densities, with high spatio-temporal resolution air pollution concentration fields from the WRF-EMEP4UK atmospheric chemistry transport model, to derive more realistic estimates of population exposure to NO<sub>2</sub>, PM<sub>2.5</sub> and O<sub>3</sub>. We explicitly allocated workday exposures for weekdays between 8:00 am and 6:00 pm. Our analyses covered all of the UK at 1 km spatial resolution. Taking workday location into account had the most pronounced impact on potential exposure to NO<sub>2</sub>, with an estimated 0.3 mg m<sup>-3</sup> (equivalent to 2%) increase in population-weighted annual exposure to NO<sub>2</sub> across the whole UK population. Population-weighted exposure to PM<sub>2.5</sub> and O<sub>3</sub> increased and decreased by 0.3%, respectively, reflecting the different atmospheric processes contributing to the spatio-temporal distributions of these pollutants. We also illustrate how our modelling approach can be utilised to quantify individual-level exposure variations due to modelled time-activity patterns for a number of virtual individuals living and working in different locations in three example cities. Changes in annual-mean estimates of NO<sub>2</sub> exposure with inclusion of workday location are considerably higher than the population average. Conducting model-based evaluations as described here may contribute to improving representativeness in studies that use small, portable, automatic sensors to estimate personal exposure to air pollution.

### **O03.02.17. Mitigation of Commuter's Air Pollution Exposure Via Personal Choices: Exploring Exposure Metrics**

Nicholas Good

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**Abstract:** In the developed world some of the highest air pollution exposures are experienced when commuting on roadways. Choice of route and transit mode have implications for the harmful dose of air pollution received; however, few studies have assessed how these factors influence exposure in real-world settings. In this study, we quantified the differences in cyclists' and drivers' air pollution exposure accounting for inhalation and commute duration under realistic conditions and assessed whether pollution intake can be changed by choice of route and mode. Personal exposure to black carbon (BC), carbon monoxide (CO), PM<sub>2.5</sub> (the mass of particles < 2.5µm in diameter), and particle number (PN) were measured for 45 commuters over approximately 700 commutes. Each commuter drove and cycled to and from their workplace via direct and alternative routes designed to lower exposure levels. Commuter's inhalation was modeled using their measured heart rate and physiological variables. Differences in commuter's mean exposure levels (when comparing combinations of various route/mode choices for the four pollutants) ranged from -66% to 96% and were strongly impacted by differences in their minute ventilation rate and trip duration. On comparable direct routes cyclists inhaled: 460% [95% Confidence Interval (CI): 306%, 638%] more BC, 98% [95% CI: 38%, 173%] more CO, 727% [95% CI: 435%, 1073%] more PM<sub>2.5</sub>, and 552% [95% CI: 263%, 1010%] more PN than when driving. On routes designed to avoid traffic cyclists saw reductions in the amount of pollution they inhaled: -36% [95% CI: -53%, -8%] less BC, -44% [95% CI: -63%, -15%] less CO, -26% [95% CI: -53%, 15%] less PM<sub>2.5</sub>, and -9% [95% CI: -46%, 62%] less PN compared to cycling directly along larger roads. These results suggest a fraction of the additional air pollution inhaled when cycling compared to driving can be mitigated by choice of route in a mid-sized city.

**003.02.18. Personal Exposures to Ambient Particulate Matter (PM) Versus Ambient PM Concentrations as a Metric for the Relationship of Daily Cardiovascular Mortality with Daily Air Pollution (Phoenix, AZ, 1957-1958)**

William Wilson

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Abstract: The amount of ambient PM found indoors is less than the ambient PM concentration. Since people spend much of their time indoors, the ambient concentration (AC) will be a noisy surrogate for personal exposure to ambient (PEA). In this paper, we will estimate the average daily personal exposure to both PM<sub>2.5</sub> and PM<sub>10-2.5</sub> and use this time series to estimate the relationship between daily PEA and daily cardiovascular mortality (CVM). We will compare these relationships with those found for AC and CVM. For a house with windows closed and few openings of doors, the air exchange rate,  $a$ , depends on the temperature difference between indoors and outdoors. From the literature,  $a=0.176+0.0162\bullet\Delta T(\text{OC})$ , based on daily measurements for a year. The ratio of the indoor concentration of an ambient air pollutant to the concentration of that ambient air pollutant outdoors, the infiltration factor, is given by  $P a/a+k$  where  $P$  is the penetration efficiency and  $k$  is the deposition rate. From the literature we have  $k(\text{PM}_{2.5})=0.39$ ,  $k(\text{PM}_{10-2.5})=1.01$  and  $P=1$  for both.  $\Delta T$ =the absolute value of the difference between the average daily temperature and an estimated indoor temperature of 21.1°C (70°F). We can now estimate the daily, community-average, indoor concentrations of PM and use these values as surrogates for PEA. For a city like Phoenix, where >99% of the homes are air-conditioned, and using CVM of people  $\geq 65$ , the indoor concentration should be a reasonable surrogate for PEA. Results will compare betas, t-statistics, and % Increases in Risk with  $\pm 95\%$  CI for individual lag days out to lag day 10 and for a combined beta for all lag days with  $t>0.5$  for both PMs. The relationship with AC is useful because air quality standards are based on ambient concentrations. However, PEA gives greater betas and greater statistical significance, supporting the importance of air pollution as a health hazard. For the same personal exposures, PM<sub>2.5</sub> and PM<sub>10-2.5</sub> are equally hazardous.

## 003.02D. Geographic Location and Cancer

### **003.02.19. Arsenic and Bladder Cancer: Very High Mortality Continues >50 Years after First High Exposure**

Taehyun Roh

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**Abstract: Background/Aim:** The city of Antofagasta, the major city in northern Chile, had a specific period (1958-1970) with very high arsenic water concentrations of around 870 ug/L. We previously reported increased mortality associated with this arsenic exposure for 1981-2000, and separately for 2001-2010. In this paper, we compare bladder cancer mortality in Antofagasta with the that of the rest of Chile between these two periods. **Methods:** The age and gender specific numbers of bladder cancer deaths in Antofagasta were compared with expected numbers based on the rest of Chile for the two periods 1989-2000 and 2001-2010, and Standardized Mortality Ratios (SMRs) and attributable risks were estimated. We also made comparisons between different birth cohorts. **Results:** The overall SMRs for bladder cancer for Antofagasta were 8.8 (95% CI, 7.9-9.8) in 1989-2000, and 6.2 (95% CI, 5.6-6.9) in 2001-2010. The attributable risks among the exposed were 89% and 84%, with 296 bladder cancer deaths attributable to arsenic in the period 1989-2000, and 280 in the period 2001-2010. For those in the 1958-1970 birth cohort, who if born in Antofagasta would have experienced very high early life exposure, the SMRs were 38.3 (17.5-72.7) in 1989-2000 and 16.0 (10.1, 25.4) in 2001-2010. **Conclusions:** The relationship between arsenic in drinking water and subsequent bladder cancer mortality is quite extraordinary and without precedent in environmental epidemiology, including major impact among those who probably experienced early life exposure.

## **003.02.20. Residential Proximity to Agricultural Herbicides during Pregnancy and Childhood Leukemia in the Danish National Birth Cohort**

Deven Patel

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**Abstract:** Background The majority (61%) of Denmark's land cover is agricultural. Cereals and grains are the major crops, and almost all acres of these crops are treated with herbicides. Based mostly on case-control studies, parental exposure to pesticides during pregnancy has been associated with increased risk of childhood cancer. Methods The Danish National Birth Cohort (DNBC) enrolled over 100,000 pregnant women 1996-2003. For childhood leukemias (diagnosed <15 years) through 2014 and 10% of the cohort (N=9,362, excluding non-singleton births and children with Down Syndrome), we linked addresses during the pregnancy to crop maps and crop-specific pesticide sales data to estimate the amount (g) of herbicides applied at distances within 100, 250, 500, 1000m of homes. We used Cox proportional hazard models to estimate hazard ratios (HR) and 95% confidence intervals (95%CI) for 18 herbicides with the highest use. Results There were 191 children diagnosed with childhood cancer, including 61 leukemia cases. Some herbicides were used on the same crops or applied as mixtures, resulting in high correlations (Spearman's rho: 0.46-1.00). For the highest tertile (vs. no pesticide use) within 500m from the home, we found increased risk of leukemia for MCPA+methabenzthiazuron (HR: 2.08, 95%CI: 1.06-4.07), dichlorprop-p/mecoprop-p (HR: 2.10, 95%CI: 1.07-4.11), benzonitrile herbicides (HR: 2.21, 95%CI: 1.14-4.29), thifensulfuron-methyl (HR: 2.09, 95%CI: 1.07,4.09), bentazone (HR: 2.20, 95%CI: 1.13-4.27), and phenmedipham (HR: 2.16, 95%CI: 1.10-4.23), without significant trends. Risk patterns at other distances from the home were similar but attenuated. There was no association with leukemia and use of glyphosate, clopyralid, 2,4-D, and 6 other herbicides. Conclusions This is the first prospective study to evaluate residential proximity to pesticide applications and childhood cancer, and provides additional evidence that pesticide exposures during pregnancy may increase childhood leukemia risk.

### **003.02.21. Brain Cancer Cluster Investigation Around a Factory Emitting Dichloromethane**

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**Abstract:** Background: The health risks associated with dichloromethane (DCM) for the general population living near industrial activities have not yet been quantified, primarily due to lack of epidemiological datasets. In the absence of such human data, we undertook a cancer cluster investigation in Cyprus around a historically using DCM plant producing shoe soles that were globally exported. We designed the methodology to investigate the possible existence of a cancer cluster in the area around the factory (point zero) and within a radius of 500 meters. Methods: A retrospective comparative population study was designed using a group of cancer patients living or working in the chosen geographical area around the factory. Results: Mean stack emissions of DCM of 88mg/Nm<sup>3</sup> and flow rates of 850 g/h exceeded the permissible DCM limits established for industrial zones. Brain and central nervous system (CNS) cancer incidence rates showed significant ( $P < 0.001$ ) increase in the study area around the plant when compared with those observed in other areas of Cyprus. Calculated standardized incidence ratios for brain/CNS after adjusting for the age at diagnosis ranged from 11.3-25.7 [mean 6.5 (3.02 : 12.3)] for the study area. Conclusions: We showed the association between chronic, unintentional DCM exposures and brain/CNS cancer cases for the general population located in a residential area being in close proximity with a plant historically emitting DCM.

### **003.02.22. Geographic Location and Its Contribution to Disparities in Ovarian Cancer Survival**

Carolina Villanueva

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**Abstract:** Background: Over 14,000 American women die of ovarian cancer (OC) every year. Disparities in survival are observed by race and socioeconomic status (SES), even after adjusting for treatment received. Geographic location has been identified as an independent predictor of survival. This study aims to determine the impact of geographic location on advanced-stage OC survival in California (CA, USA), relative to race and SES. Methods: Women diagnosed with advanced-stage epithelial OC between 1996 and 2014 were identified through the CA Cancer Registry, with follow up obtained through 2016. Cox proportional hazard models with a smooth for residential location were used to identify geographic patterns in survival. We assessed the impact of distance traveled for care, distance to closest high-quality-of-care (QOC) hospital, race, and SES on survival, adjusting for treatment received, age, and cancer characteristics. Results: Among the 20,095 women diagnosed at late stages, survival time ranged from 0 to 20.2 years, with a median of 2.0 years. Median survival time was shortest for women of Black race (1.3 years) and the lowest SES (1.5 years). Patients who traveled the greatest distance to receive care (>32km) had better survival (hazard ratio [HR],0.85; 95% confidence interval [CI],0.80-0.90), whereas women living furthest (> 48km) from a high-QOC hospital had poorer survival (HR,1.06; 95% CI,1.00-1.14). Women of lower SES and minority race were less likely to travel far for care. Geographic location was a significant predictor of survival, even after controlling for cancer characteristics and treatment received, with Central Valley showing a significant hot spot of high HR that was attenuated after adjusting for race and SES. Conclusions: Geographic location is an independent predictor of OC mortality in CA. Traveling greater distances for care was associated with better survival. Minority women and those of lower SES are disproportionately affected by geographic barriers.

### 003.02.23. Spatiotemporal Patterns of Solar and UV Irradiances in the Contiguous United States

Ying Zhou

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**Abstract:** **BACKGROUND:** Skin cancer is the most common type of cancer in the United States. The majority of skin cancer is caused by overexposure to ultraviolet (UV) light. The National Environmental Public Health Tracking Program (EPHT) at CDC has collaborated with partners to develop and disseminate county-level daily UV irradiance (2005 to 2015) and total solar irradiance (1991 to 2012) data for contiguous United States. The objectives of this study are to present our methods for generating and evaluating UV and solar irradiance datasets, and to describe their spatial distribution and temporal trend. **METHODS:** UV dataset was derived based on measurements from Ozone Monitoring Instrument (OMI) aboard NASA's Aura spacecraft. For evaluation, erythemally weighted UV irradiance was compared with ground observations at 27 sites. Solar irradiance were extracted from National Solar Radiation Data Base (NSRDB) and SolarAnywhere data. In addition, we conducted regression analysis to understand long-term trends at both the national level and by state for UV and solar irradiances. **RESULTS:** When comparing UV irradiance from OMI with ground observations, the correlation coefficients range from 0.66 to 0.93 with an average of 0.86. Solar and UV irradiances both had a latitudinal gradient increasing towards the South, and a longitudinal gradient increasing towards the West. The lowest state averages occurred in Vermont for solar irradiance and Maine for UV irradiance. The highest state averages were both in Arizona. National annual average solar and UV irradiances both increased significantly over the years included in this analysis. We made both datasets available to the public through CDC's EPHT network. **CONCLUSIONS:** The UV dataset is currently the only publicly available, spatially resolved long-term UV radiation dataset covering the contiguous United States based on latest satellite remote sensing technique. These datasets allow for improved characterization of UV and sunlight exposure.

### 003.02.24. Towards Continuous Domain Models in Spatial Epidemiology

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Abstract: One of the goals of spatial epidemiology is to identify areas with elevated disease risk. Such analyses are often hampered by the limited geographical resolution of the available data. When data are aggregated into spatial units, conditional autoregressive (CAR) models are commonly used. When data are available at higher resolution (e.g. geocodes), log-Gaussian Cox processes (LGCPs) provide a more natural modelling framework. In theory, LGCPs should perform better, but do they? We simulated data mimicking childhood leukaemia incidence in the Canton of Zurich in Switzerland (n=334 during 1985-2015). Geocoded locations of residence were available for the entire population. We randomly sampled case locations from these data under different risk scenarios. We considered 39 scenarios varying the shape of the true risk function (constant, step-wise, exponential decay), size of the high-risk areas (1, 5 and 10 km radii), risk increase in the high-risk areas (2 and 5-fold) and the number of cases (n, 5n and 10n). We compared the ability of the models to recover the true risk surface using the root mean integrated squared error (RMISE) and their ability to identify high-risk areas using area under the ROC curve (AUC). CAR models recovered the step-wise true risk surface with lower error across all scenarios (range of median RMISE across scenarios: 0.05-0.25) compared to LGCPs (median RMISE: 1.80-37.2). For exponential decay risk surfaces, however, LGCPs performed better (median RMISE: 1.70-20) compared to CAR (median RMISE: 1.80-32) in almost all scenarios. The ability to detect high-risk areas was higher for LGCPs (median AUC: 0.81-1) compared to the CAR model (median AUC: 0.65-0.93) across almost all scenarios. Our simulation study suggests that, under realistic scenarios, continuous domain models outperform discrete domain models in estimating risk surfaces and identifying high-risk areas. This argues for moving towards continuous domain models in spatial epidemiology.

## 003.02E. Health Effects Related to PCBs Exposure

### **003.02.25. Prenatal Exposure to Polychlorinated Biphenyls and Mercury Are Associated with Insulin-Like Growth Factor 1 and Thyroid-Stimulating Hormone in Cord Plasma**

Miyuki Iwai-Shimada

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**Abstract:** Impact on maternal endocrine system during pregnancy may also affect growth and development of a fetus. Certain toxic elements and polychlorinated biphenyls (PCBs) are known to disturb human endocrine system. In our previous study, we showed that birth weight were affected by prenatal PCBs and methylmercury exposure. In this study, we used the data from the Tohoku Study of Child Development in Japan. The objective of the study was to evaluate the effect of prenatal exposure to methylmercury, arsenic, cadmium, lead, and PCBs on insulin-like growth factor 1 (IGF-1) and thyroid related hormones (TSH, T3, freeT3, T4 and freeT4) in cord blood. Those factors are considered to be associated with fetal growth. Elements except for mercury were analyzed by an inductivity coupled plasma mass spectrometry. Mercury levels were measured using a cold vapor atomic absorption spectrometer. IGF-1 and insulin-like growth factor binding protein 1 (IGFBP1) were determined by an enzyme-linked immunosorbent assay (ELISA). Thyroid related hormones were assessed by an electrochemiluminescence immunoassay. The data were examined by Pearson's correlation and multiple regression analyses. The IGF-1 in cord plasma was negatively associated with PCB concentrations in cord blood, especially with tri-, tetra-, penta-, hexa- and hepta-chlorobiphenyls. Cord plasma free T4 was negatively associated with mercury concentrations in cord blood. This study indicated PCBs and mercury could affect birth weight through altering the IGF1 and T4 mechanism. Further studies are necessary to investigate the effect of decrease in IGF-1 and thyroid hormones on birth weight.

### 003.02.26. Intrauterine Exposure to Polychlorinated Biphenyls (PCBs) and Anogenital Distance in Israeli Newborns

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Abstract: Polychlorinated biphenyls (PCBs) are widespread environmental contaminants due to their extensive past use, long-range transport and persistence in adipose tissues of humans and animals. Specific congeners exhibit structural similarities to steroid hormones. This raises concerns regarding the effects of exposure on reproductive development in neonates. Here, we examine associations between prenatal exposure to PCB congeners 118, 138, 153 and 180 and anogenital distance in a cohort of newborns in Israel. We measured serum concentrations of the four PCB congeners in 173 pregnant women presenting to the delivery room at Assaf Harofeh Medical Center. Mothers completed questionnaires on lifestyle and demographic variables. Birthweight, length, head circumference and anogenital distances were measured using a standard protocol. Regression models estimated associations between maternal PCB exposure and infant anogenital measurements, birthweight, birth length and head circumference, controlling for confounding variables. Mean penile width, anoscrotal length, and anopenile length were 11.04 mm [standard deviation (sd): 1.14 mm], 23.43 mm (sd: 3.58), and 44.58 mm (sd: 4.58 mm) in male infants (n=90); mean anoforchetall and anoclitoral distances were 14.34 mm (sd: 2.17 mm) and 34.23 mm (2.74 mm) in female infants (n=83). Mean maternal serum concentrations were 2.91 ng/ml (sd: 1.93), 4.50 ng/ml (sd: 3.04), 7.42 ng/ml (sd: 5.41), and 4.98 ng/ml (sd: 3.62) for PCB-118, 138, 153 and 180, respectively. Higher maternal concentrations of all four PCBs were associated with reduced anogenital distance measures in male infants but not in female infants. No associations were found between PCB exposure and birthweight, length and head circumference. These results are significant as anogenital distance is associated with male reproductive problems later in life; thus, there are implications for later life reproductive health.

### **O03.02.27. Associations of in Utero Polybrominated Diphenyl Ethers (PBDEs) and Polychlorinated Biphenyls (PCBs) with the Mid-Childhood Gut Microbiome**

Hannah Laue

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**Abstract:** Background: The gut microbiome is influenced by early-life exposures, but-despite potentially enormous implications for child health-it is understudied in environmental health. This pilot study, the first to explore the effect of in utero exposures on long-term development of the microbiome, examined the association between first trimester and perinatal exposure to PBDEs and PCBs and the mid-childhood gut microbiome. Methods: We measured metabolites of PBDE-47, -99, -100, and -153 and PCB-138, -153, and -180 in maternal plasma during the first trimester (n=18) and at delivery (n=25) using gas chromatography coupled with tandem mass spectrometry in women from Sherbrooke, Quebec who identified as white and ever breastfed the child subject. The structure of the mid-childhood (6-8 years) fecal microbiome was measured using 16S rRNA sequencing. Sequences were processed using QIIME and paired to operational taxonomic units (OTUs) using SILVA v128. To test for differences at the OTU level, we used the MiCAM algorithm, adjusting for delivery mode and socioeconomic status. Results: Higher first trimester PCB-153, -180, and  $\Sigma$ 3PCB blood concentrations were associated with a higher relative abundance of Propionibacteriales and Propionibacteriaceae in mid-childhood. Higher PCB-180 and  $\Sigma$ 3PCB were associated with higher relative abundance of Bacillales Family XI. Higher PBDE-99 exposure was associated with a decrease in uncultured bacteria within the Ruminococcaceae NK4A214 group and PBDE-47 was associated with differences in Ruminococcus 2, but the direction of the association varied by lower-level taxa. These OTU-level changes did not result in differences to within- or between-subject diversity. Exposures at delivery were not associated with differences in OTUs. Conclusion: Early-life exposure to PCBs and PBDEs was associated with differences in the mid-childhood gut microbiome. Larger studies are needed to confirm these results and explore health implications.

**O03.02.28. Polychlorinated Biphenyls, Thyroid Hormones, and Neuropsychological Functioning over a 14-Year Period, among Healthy, Older Adults from New York State**

Eva M Tanner

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**Abstract:** Polychlorinated biphenyls (PCBs) are neurotoxic persistent organic pollutants linked to changes in thyroid hormones (THs) and cognitive function in older adults. However, no prior studies have evaluated the association over time. We assessed the effect of serum PCB levels on THs and neuropsychological tests (NPTs) over a 14-year period among men and women, ages 67 to 88 years, from New York State. We analyzed serum for PCBs using gas-chromatography-isotope dilution mass-spectrometry, enzymatically measured 5 THs and 2 TH-transport proteins, and administered a battery of 33 NPTs. Of the original 253 participants, the 116 that completed follow-up were significantly younger, more physically active, and had higher income and NPT scores. Baseline serum PCB levels were higher than the general US population, but significantly declined over time (-18%). We found that 75% higher baseline PCB levels were associated with 4.5% lower free triiodothyronine (fT3) (CI=-8.0%, -1.0% p-value=0.013), and 3.8% higher transthyretin (TTR) (CI=0%, 7.7% p-value=0.047) levels at follow-up, adjusted for age, sex, smoking, TH medication, and follow-up time. No other THs were impacted. PCBs were not significantly related to NPTs at follow-up, or change in NPT scores over time, after adjusting for age, sex, smoking, total lipids, and follow-up time. Adjustment for loss to follow-up using multiple imputation and inverse probability weighting had minimal impact on estimates, but we cannot rule out healthy survivor bias. Results suggest that among healthy older adults with low to moderate exposure, PCBs were related to subtle decreases in fT3 and increases in TTR over time, but not cognitive function. Future studies among older adults should conduct more frequent follow-up assessments to mitigate the potential impacts of selective survival, and evaluate health habits that may be neuroprotective.

### **O03.02.29. Environmental Exposures to PCDDs, PCDFs, and PCBs and Mechanism of Steatohepatitis in the Anniston Community Health Survey II**

Matt Cave

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Abstract: PCDDs, PCDFs, and some PCBs activate the aryl hydrocarbon receptor (AhR); but non-dioxin like (NDL) PCBs do not. We previously reported a high prevalence of suspected nonalcoholic steatohepatitis (NASH) associated with PCB exposures in the Anniston Community Health Survey (ACHS). Here, we determine if dioxins and NDL PCB exposures were associated with serologic biomarkers of NASH in the subgroup of ACHS-II participants with suspected liver disease. The total dioxin toxic equivalency (TEQ) was determined by summing the TEQs for serum PCBs, PCDDs, and PCDFs using WHO toxic equivalency factors. Disease biomarkers were measured by ELISA or Milliplex. Subjects were categorized as having suspected liver disease if serum cytokeratin 18 was elevated. Linear regression models examined associations between TEQ or  $\Sigma$ NDL PCBs with NASH biomarkers in the suspected liver disease subgroup. In 345 adult participants, the prevalence of suspected liver disease was 62%. These subjects were at risk for NASH due to a high prevalence of overweight/obesity and diabetes. Suspected liver disease was significantly associated with male sex, non-Hispanic White race/ethnicity, increased liver enzymes, and a trend towards increased diabetes. Both TEQ and  $\Sigma$ NDL PCBs were associated with altered intermediary metabolism biomarkers (increased LDL, VLDL, phospholipids; and decreased HOMA-IR). TEQ was also associated with decreased HOMA-B. TEQ was associated with increased TNF $\alpha$ , IL-12 and CXCL11; while  $\Sigma$ NDL PCBs was associated with increased IL-13. Both TEQ and  $\Sigma$ NDL PCBs were positively associated with TGF $\beta$ . Neither exposure biomarker was positively associated with either CK18 or transaminases. In ACHS-II participants with suspected liver disease we found associations with altered biomarkers of liver intermediary metabolism, inflammation, fibrosis, and synthetic function; but not cell death. The potential role of the AhR, dioxins, and NDL PCBs in NASH progression warrants further investigation.

### **003.02.30. Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) in Early Adulthood and Blood Lipids over a 23-Year Follow-Up**

Jose Suarez-Lopez

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**Abstract:** Background: Some evidence in humans suggests that persistent organic pollutants (POPs), including organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs), may alter the blood lipid composition. We analyzed associations between blood POPs concentrations in young adulthood with blood lipid levels up to 23 years later. Methods: The study included 180 participants (50% diabetic and 50% without diabetes). Serum POPs were measured in year 2 of follow-up (participant ages 20-32y), and lipids in plasma at follow-up years 2, 7, 10, 15, 20 and 25. 32 POPs were detectable in  $\geq 75\%$  of participants (23 PCBs, 8 OCPs and PBB-153). We created summary scores for PCBs and OCPs for both wet-weight, and lipid standardized (LP) concentrations. We used repeated measures regression adjusting for demographic factors, BMI, smoking, diabetes status, among others. Results: We observed positive associations of the 23 LP-PCB score with total cholesterol ( $\beta$ per SD increase [95%CI]: 5.0 mg/dL [0.7, 9.2]), triglycerides (7.8 mg/dL [-0.9, 16.5]), LDL (4.2 mg/dL [0.2, 8.2]), oxidized LDL 3.4 U/L (-0.05, 6.8), and cholesterol/HDL ratio (0.2 [0.02, 0.3]). The associations for triglycerides (14.7 mg/dL [0.4, 20.1]), cholesterol/HDL (0.33 [0.09, 0.56]) and, to some extent, LDL (4.7 mg/dL [-1.6, 10.9]) were only observed among participants in the upper 50th percentile of BMI. PBB-153 had positive curvilinear associations with most outcomes. Conclusions: PCBs and PBB-153 measured in young adulthood were positively associated with prospective alterations in most blood lipid components, with evidence of effect modification by BMI. Further longitudinal studies with multiple measures of POPs overtime are needed.

## O03.02F. New Advancements in Consumer Exposure Risk Assessment

### **O03.02.31. High-Throughput Exposure Modeling for 8000 Tox21 Chemicals in the Environment and in Consumer Products Based on a Modified USEtox Model**

Olivier Jolliet

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Abstract: Near-field human exposure to chemicals in consumer products has been gaining increased attention. However, exposure models used in life cycle impact assessment and risk assessment are usually limited to chemicals emitted to the far-field environment. We thus developed a framework based on the widely used USEtox model to integrate near-field chemical exposures, which converts transfer rate constants to direct transfer fractions from emission to receiving compartments, and connects near-field compartments (product, near-person air) with far-field compartments (e.g. air, water, soil) via wastewater treatment and landfill. By inversion of the direct transfer fraction matrix, cumulative transfer fractions from products to various human receptors are obtained, also known as product intake fractions (PiFs). The direct transfer fractions from different product and emission scenarios are calculated by 7 underlying models (skin surface, object surface, article interior, indoor air, food contact material, pesticide, direct environmental emission). Our framework was applied in batch mode to generate high-throughput estimates of PiFs for 8167 Tox21 chemicals via four pathways: near-field (residential), dietary, far-field industrial, and far-field pesticide. The total PiF summing users and non-users (i.e., general population) across all exposure routes for the 8167 chemicals ranges from 1.9E-4 to 0.34, from 4.8E-6 to 0.19, and from 6.3E-6 to 0.22 via residential, dietary and far-field industrial pathways, respectively. For the far-field pesticide pathway, the total PiF ranges from 1.9E-7 to 0.1 and from 2.9E-5 to 0.09 assuming herbicide and non-herbicide applications on tomatoes, respectively. In general, the residential pathway is associated with the highest total PiF, again highlighting the importance of near-field chemical exposures. Further efforts are needed to identify the chemicals that are actually associated with the various pathways to obtain more refined estimates.

### **003.02.32. Health Risk Assessment of Inhalation Exposure to Long-Chain Aliphatic Hydrocarbons and Aldehydes, TMB, MCH, and MIBK in Indoor Environments**

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**Abstract:** Background: In the past decades, indoor air pollution has become a major public health concern. Therefore, Japan has established indoor air quality guidelines for 13 chemicals, including formaldehyde and toluene. However, the types and concentrations of these pollutants have not been consistent over time due to alterations in lifestyle and development of novel household products and building materials. Our recent nationwide surveys in Japan revealed that C8-C16 aliphatic saturated hydrocarbons, C6-C9 aliphatic saturated aldehydes, trimethylbenzenes (TMBs), methylcyclohexane (MCH), and methyl isobutyl ketone (MIBK) have been frequently detected in high concentrations in indoor air samples taken from houses. However, the risk levels have not been assessed to date. Methods: We derived the reference concentrations (RfCs) for these pollutants and assessed their risk levels. RfC is an estimation of a continuous inhalation exposure concentration that is not likely to carry an appreciable risk of deleterious health effects. Results: RfCs derived for the different pollutants were as follows: for hydrocarbons, RfC of 246  $\mu\text{g}/\text{m}^3$  from no-observed adverse effect level (NOAEL) of 138  $\text{mg}/\text{m}^3$  (adrenal gland effects in rats) and uncertainty factor (UF) of 100; for aldehydes, RfC of 130  $\mu\text{g}/\text{m}^3$  from lowest-observed adverse effect (LOAEL) of 363  $\text{mg}/\text{m}^3$  (nasal effects in dogs) and UF of 500; for TMBs, RfC of 110  $\mu\text{g}/\text{m}^3$  from NOAEL of 123  $\text{mg}/\text{m}^3$  (neurobehavioral effects in rats) and UF of 200; for MCH, RfC of 2857  $\mu\text{g}/\text{m}^3$  from NOAEL of 1600  $\text{mg}/\text{m}^3$  (renal effects in rats) and UF of 100; and for the MIBK, RfC of 329  $\mu\text{g}/\text{m}^3$  from LOAEL of 1845  $\text{mg}/\text{m}^3$  (renal effects in rats) and uncertainty factor (UF) of 1000. In our surveys, the maximum concentrations of hydrocarbons, aldehydes, TMBs, MCH, and MIBK were 1456  $\mu\text{g}/\text{m}^3$ , 250  $\mu\text{g}/\text{m}^3$ , 368  $\mu\text{g}/\text{m}^3$ , 481  $\mu\text{g}/\text{m}^3$ , and 151  $\mu\text{g}/\text{m}^3$ , respectively. Conclusion: Our results suggest that the risk levels for hydrocarbons, the aldehydes, and TMBs indicate a "potential for health risk".

### **O03.02.33. Prediction of Composition and Emission Characteristics of Articles in Support of Exposure Assessment**

Cody Addington

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Abstract: The risk to humans from chemicals in consumer products is dependent on both hazard and exposure. The prediction and quantification of chemical exposure from household articles such as furniture and building materials is an ongoing effort. As opposed to, for example, cosmetic formulations which are regulated by the FDA, the chemical composition of articles are less clear, as are the resulting chemical emission characteristics and exposures. We have developed a modeling methodology to predict the weight fraction of chemicals in a polymeric substrate and corresponding emission characteristics based on chemical and substrate structure. We constructed a database of reported and measured chemical concentrations in articles from publicly available sources including Health Product Declarations (HPDs). This database was then used to train a random forest algorithm which predicts a chemical weight fraction bin based on chemical structure and properties. From the predicted weight fractions and chemical properties, we applied a group contribution method, UNiversal quasi-chemical Functional-group Activity Coefficients-Free Volume (UNIFAC-FV), to approximate steady-state gas phase concentrations ( $y_0$ ) at the substrate surface. The model was compared to published experimental  $y_0$  data from chamber experiments. The resulting estimates of  $y_0$  can be used to parameterize existing high-throughput exposure models for substrate-chemical combinations found in consumer articles. Thus, from only the "first-principles" of chemical and substrate molecular structure, we can generate an estimate of chemical exposure for use in screening-level risk evaluation. This abstract does not reflect EPA policy.

### **O03.02.34. Determination of Chemical Constituents of Recycled Consumer Products**

Charles Lowe

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Abstract: Recycled materials are commonly found in various modern consumer products. Although these products are generally regarded as being comparable to those made from non-recycled (virgin) materials, differences in chemical formulation may be unknown to the consumer or even manufacturer. A suspect screening analysis was applied to 215 products (159 recycled and 56 virgin) across 7 categories (including plastic children's toys, housing construction materials, and paper products) to rapidly characterize chemical content. Two-dimensional gas chromatography time-of-flight mass spectrometry (GCxGC-TOFMS) was performed on samples extracted with a standardized methodology. Tentatively identified and confirmed chemicals and estimated concentrations were determined by comparing sample spectra to the National Institute of Standards and Technology v.2.2.07-2014 spectral library. A total of 1,042 chemicals were tentatively identified in recycled materials and 677 in virgin materials. Recycled materials contained larger numbers of flame retardants, fragrances, and colorants. A random forest model was constructed which used the presence/absence of the tentatively identified compounds to classify products as made of recycled or virgin materials. The model was validated using 5-fold cross validation and Y-randomization and achieved a balanced accuracy of 76%. Hierarchical clustering analysis was performed to identify groups of chemicals potentially associated with unique exposure sources (e.g., recycling processes). While presence in a product is only a prerequisite to exposure, the occurrence of chemicals that are unexpected or common across multiple products can guide research priorities. The chemicals and associated concentrations identified in this study can be used in future studies to parameterize existing exposure models or identify novel exposure pathways which are currently neglected in product exposure assessments. This abstract does not necessarily reflect US EPA policy.

### **O03.02.35. A Review of Global Legal Regulations on the Permissible Levels of Heavy Metals in Cosmetics with Special Emphasis on Skin Lightening Products**

Bian Liu

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**Abstract:** Introduction the use of skin lightening products to inhibit melanogenesis is common among non-White populations. The practice has historically been associated with complexion- and/or race-related oppression and classism, but more recently has been perceived as an ungendered fashion trend. Chronic exposure to heavy metals found in many bleaching cosmetics may have serious health consequences, perhaps prompting the need for stricter regulations. Aims of the study Our study aimed to assess the current global legal regulations regarding the permissible content of four heavy metals (mercury, lead, arsenic, and cadmium) in cosmetic products and to explore whether the composition of skin bleaching products has adhered these regulations. Materials and methods We comprehensively reviewed publicly-available regulations on cosmetic products, extensively searching websites of relevant international organizations or government bodies. No language, regional, or temporal restrictions were applied. Results Fifty-five countries had regulations on the permissible content of heavy metals in skin lightening products. Approximately 46 countries had regulations for all four heavy metals, with varied maximum permissible levels and effective year of regulation. In both developed and developing countries, cosmetics with heavy metal content above the permitted limits were reported. Conclusions Legal regulations on heavy metals in skin lightening cosmetics exist in many high- and middle-income countries, while lacking in low-income countries. There is a need for enforcement of existing rules, and rigorous assessment of the effectiveness of these regulations. Moreover, there is a need for the global harmonization of the above standards, given increasing availability of skin lightening products including online sales. Meanwhile, education of consumers and cross-national sharing of information on cosmetics are needed to reduce the scope of the possible adverse effects of using skin lightening products.

### **O03.02.36. Estimation of Exposure to Preservatives from Modelling Clays and Slimes Use in Korea**

Ji Young Park

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Abstract: Modelling clays or slime have been used for art activities or playing thus popular to children. They may include preservatives to avoid the bacterial growth. Some preservatives can pose harmful effects. The purpose of this study was to investigate the contents of preservatives and to estimate dermal exposures of preservatives in modelling clays and slimes use by children. Sixty five modelling clays and fifteen slimes were selected and were analysed for preservatives. The nationwide survey was performed to get use patterns of modelling clays and slimes by home visit survey of 10,000 children divided into three age groups: 0~2, 3~6, and 7~12 years old. Based on chemical analysis results and exposure factors from nationwide survey, dermal exposure estimates were calculated using deterministic method and were determined by each age group. Five preservatives were detected: triclosan (range:7-261 µg/kg in clays, 132-153 µg/kg in slimes, detection rate 24/80), methyl paraben (7.1-3220 in clays, not detected in slimes, 6/80), methylisothiazolinone(MIT, 1.6-12 in clays, 1-5.7 in slimes, 22/80), chloromethylisothiazolinone(CMIT, 4-96 in clays, 2.2-43 in slimes, 21/80), octylisothiazolinone(OIT, 10-130 in clays, 85-93 in slimes, 23/80). Proportions of clays and slimes user population were 69.2% and 45.8%, and mean use frequencies were 5.4 and 9.8 per month, respectively. Mean times spent to play with products each use were 23 min (range: 5~200) and 17 min (range: 5~100). Exposure estimates of modelling clays were higher than those of slimes. For modelling clays, exposure estimate was the highest in 3-6 years old age group and for slimes, 7-12 years old group was the highest. Exposure levels were estimated based on the use pattern information representing children in Korea. Harmful preservatives were found in modelling clays and slimes. Depending on exposure pattern, these products use could cause unacceptable risk in worst cases.

## O03.02G. The Influence of Chemical Exposures on Vulnerable Populations

### O03.02.37. Iron Status and Its Associations with Blood and Plasma Divalent Metals among Children Aged 3 to 19 Years Old from Four First Nation Communities in Quebec

Emad Tahir

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**Abstract:** **OBJECTIVES:** In First Nations communities, iron deficiency (ID) is a frequent pediatric condition with diverse adverse outcomes. Iron is a divalent metal that share absorptive pathways with cadmium (Ca), cobalt (Co), manganese (Mn), lead (Pb) and zinc (Zn) in the gastrointestinal tract; ID upregulates their uptake and the likelihood of toxic levels in humans. The present study examines associations between ID status, its determinants, and other divalent metals among indigenous youth. **METHODS:** The 2015 First Nation Youth Environment and Health (JES! -YEH!) pilot study was conducted among children (3 to 19 y, n = 198) from four First Nations communities in Quebec. Blood and urine samples and anthropometric measurements were collected. Serum ferritin (SF), blood Cd, Pb, Mn, Co, plasma Zn urinary cotinine and hs-CRP levels were measured. Determinants (including traditional and market food consumption) were assessed using an interview-administered questionnaire, based on which nutritional intakes were calculated. Descriptive analyses and Structural Equation Models were used to test associations. **RESULTS:** There was a high prevalence of ID (21.8%). Fruit and juice consumption - via vitamin C intake - were the only food variables positively associated to SF (coefficient [95% CI]: 0.22 [0.11, 0.45]; 0.54 [0.28, 0.80]). Blood Mn was significantly higher than in the Canadian Health Measures Survey. SF was in turn inversely associated to blood Co and Mn (-0.26 [-0.34, -0.19]; -0.15 [-0.20, -0.11]). As a whole, fruits and juice consumption were inversely associated with blood Mn (-0.02 [-0.03, -0.01], -0.04 [-0.08, -0.01]) and Co (-0.03 [-0.06, -0.01], -0.07 [-0.14, -0.02]), via their positive association to vitamin C intake and SF. **CONCLUSIONS:** Our findings suggest that dietary interventions fostering higher consumption of foods naturally rich in vitamin C, which is known to enhance iron absorption, could decrease ID and ultimately, restore blood Mn and Co homeostasis.

### **003.02.38. Determinants of Selenoneine Concentration in Red Blood Cells of Inuit from Nunavik (Northern Québec, Canada) and Implications for Selenium Risk Assessment**

Matthew Little

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Abstract: Selenium (Se) is a trace element essential to human health, and is abundant in marine foods consumed by Inuit populations in Nunavik (northern Quebec, Canada), leading to exceptionally high whole blood Se levels. While most epidemiological studies examine plasma or whole blood Se, there is a dearth of research on specific Se biomarkers (e.g. selenoproteins and small Se molecules) and their health impacts. Selenoneine, a novel Se compound, is found in high concentrations in marine foods (and particularly beluga mattooq) and the red blood cells (RBCs) of populations that depend on them. We determined RBC selenoneine concentrations in Inuit adults (n=885) who participated in the Qanuippitaa? 2004 survey. Simple associations between RBC selenoneine and other Se and mercury (Hg) biomarkers were assessed, followed by a multiple linear regression analysis to determine factors (sociodemographic, lifestyle, and dietary) associated with RBC selenoneine concentrations. Selenoneine was abundant in the RBCs of this population; age and sex-adjusted geometric mean RBC selenoneine concentration was 118 µg/L (range: 1-3226 µg/L) and was much higher (p=0.001) among women (250 µg/L) than men (88 µg/L) across all regions of Nunavik after controlling for confounders. Increasing age (standardized β=0.24), higher body-mass index (β=0.07), female sex (β=0.10), living in a Hudson Strait community (compared to Hudson Bay and Ungava Bay; β=0.42), and beluga mattooq consumption (g/day; β=0.15) were positively associated with RBC selenoneine, while consumption of market meats (g/day; β=-0.08) was negatively associated with RBC selenoneine. RBC selenoneine is therefore an important biomarker of Se dietary intake from local marine foods in Inuit populations. These results underscore the need to re-evaluate risk assessments of Se intake and develop public health recommendations that reflect the complexities of Se speciation, particularly for Inuit and other populations that rely on marine foods.

### **003.02.39. Diffusion Imaging of the Corpus Callosum in Inuit Adolescents Chronically Exposed to Methylmercury**

Vincent Migneron-Foisy

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**Abstract:** Background: In comparison to the general population, the Inuit community of Northern Quebec (Nunavik) is highly exposed to environmental contaminants, in particular methylmercury. Impairments of cognitive and sensory functions in association with prenatal mercury (Hg) exposure have been previously reported in a longitudinal mother-child cohort study, the Nunavik Child Development Study (NCDS), but the brain substrates of these deficits remain to be elucidated. Methods: This study aimed at determining whether microstructural integrity of the corpus callosum, a structure implied in several brain functions, is altered by Hg exposure in 75 NCDS adolescent/young-adult participants (Mean age=18.4y; Range=16.2 to 21.9y) using diffusion Magnetic Resonance Imaging (MRI). The general fractional anisotropy (GFA) metric was extracted for 7 sections of the corpus callosum. The association between GFA and Hg blood levels at birth and at the time of MRI assessment was determined using multiple linear regressions after controlling for sex, age, alcohol/drugs dependence and co-exposure to selenium. Results: Results show that cord Hg was associated with a decrease of GFA in the rostrum ( $\beta = -.33$ ,  $p = .02$ ), i.e., the anterior part of the corpus callosum that connect the frontal lobes. This result remained significant after controlling for Hg level at time of assessment ( $\beta = -.35$ ,  $p = .03$ ). Hg level at time of assessment was associated with splenium GFA ( $\beta = .30$ ,  $p = .03$ ), the posterior section of the corpus callosum that connect the occipital cortices. However, this association was no longer significant after controlling for cord Hg ( $\beta = .26$ ,  $p = .11$ ). Conclusions: Exposure to Hg, especially exposure during fetal development, is associated with microstructural alterations of the corpus callosum in NCDS adolescents. These results are in agreement with previous findings reporting that prenatal exposure to Hg was associated with a decreased IQ and alterations in visual processing.

### **003.02.40. Risk Factors for Developing Anxiety in Inuit Adolescents from Nunavik**

Vickie Lamoureux

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**Abstract:** Background: Anxiety among Inuit adolescents in the Arctic has not previously been studied empirically, although the evidence of major anxiety-related problems in this community. In addition to describe anxiety markers, we examined their relationships with diverse developmental risk factors including exposure to environmental chemicals, a specific subject of concerns in Nunavik. Methods: Anxiety was assessed in 89 Inuit participants (Mean age=18.4y; Range=16.2 to 21.9y) enrolled in the longitudinal Nunavik Child Development Study. They completed the Screen for Child Anxiety Related Emotional Disorders (SCARED) and the State-Trait Anxiety Inventory (STAI) assessing situational (State) and general (Trait) anxiety levels. Potential risk factors of anxiety documented through follow-ups were examined at birth, at 11 years of age and at the time of assessment, including blood levels of chemicals (Hg, lead, PCBs), nutrients and vitamins, as well as age, sex, IQ, drug/alcohol, bullying, family violence, food insecurity, crowding and SES. Results: Anxiety scores on both questionnaires were high, particularly for the SCARED, which mean score was above the clinical threshold. Multiple regression results show that significant risk predictors of the SCARED scores were exposure to Hg during childhood ( $\beta=.25$ ,  $p=.02$ ) and adolescence ( $\beta=.27$ ,  $p=.004$ ), food insecurity ( $\beta=.27$ ,  $p=.004$ ), bullying history ( $\beta=.21$ ,  $p=.03$ ) and female status ( $\beta=.26$ ,  $p=.01$ ). For the STAI, the only significant predictor was IQ ( $\beta= -.27$ ,  $p=.02$ ) on Trait, whereas concentration of cord blood Hg ( $\beta=.25$ ,  $p=.03$ ), home crowding during childhood ( $\beta=.34$ ,  $p=.002$ ), adolescence ( $\beta=.23$ ,  $p=.02$ ), food insecurity ( $\beta=.22$ ,  $p=.03$ ), vitamin E ( $\beta=-.25$ ,  $p=.02$ ) and selenium ( $\beta=.21$ ,  $p=.04$ ) were found to be the significant predictors of anxiety on State. Conclusions: Our findings show that Inuit adolescents are at risk for anxiety via multiple contributing factors, particularly chronic exposure to Hg, food insecurity and female status.

**003.02.41. Jeunes, Environnement Et Santé / Youth, Environment and Health (JES!-YEH!) Pilot Project in Four First Nation Communities in Quebec: Exposure to Perfluorononanoic Acid (PFNA) and Associations with Thyroid Hormones**

Élyse Caron-Beaudoin

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Abstract: Background/Aim. Perfluorononanoic acid (PFNA) and other perfluorinated compounds have various industrial uses, and possible sources of exposure include food packaging, consumer products, house dust and/or drinking water. Exposure to PFNA in children has been associated with alteration in thyroid hormones, which have critical roles in metabolism regulation and during brain development. In 2015, the pilot project Jeunes, Environnement et Santé / Youth, Environment and Health (JES!-YEH!) was conducted among children and youth (3-19y) in collaboration with four First Nation communities in Quebec (n=198). The present study aims at evaluating the associations between various perfluorinated compounds exposure and thyroid hormones levels, while adjusting for relevant co-variables. Methods and results. During this study, perfluorinated compounds, thyroid hormones (e.g TSH and free T4) iodine and creatinine were measured in blood and urine samples. Main findings showed low exposure to major perfluorinated compounds, excepted for PFNA (GM: 2.09 µg/L). Compared to the Canadian Health Measure Survey (GM: 0.71 µg/L), PFNA levels were significantly higher among Anishinabe participants (GM: 5.12 µg/L), and particularly among those aged 6 to 11 years old (GM: 9.44 µg/L). Despite multiples efforts with community partners, no local source was identified. Few participants had abnormal TSH and free T4 levels. Conversely, preliminary analyses show positive associations between PFNA and free T4 levels (Spearman's  $r=0.23$ ;  $p=0.0016$ ). When adjusted for age, age-squared, BMI-z-score, urinary creatinine and nation, free T4 levels remain positively associated with PFNA levels (Adjusted  $\beta=0.39$ ;  $p=0.0014$ ;  $R^2 = 0.24$ ). Conclusion. Overall, this pilot project suggest potential effects of PFNA as an endocrine disruptor, and highlight the importance of better investigating the sources and effects of disproportionate exposure to emerging environmental contaminants in indigenous communities.

### **O03.02.42. Getting It Right for Aboriginal People Gets It Right for Everybody: Reflections from Australia**

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Abstract: In 1997, the Australian National Health and Medical Research Council (NHMRC) realised that despite substantial epidemiological research on Aboriginal health, health disparities were not reducing. 'Research' was viewed as something done 'on' not 'with' Aboriginal people; some felt they were 'the most researched people on Earth'. Extensive Aboriginal-led consultation processes culminated in three 'NHMRC Road Maps' that inform ethical guidelines and funding, driving substantial change in the people, process and impacts of Aboriginal health research. Among the Road Map consultation's central tenets is the ultimate aim of Aboriginal health research to enhance Spirit and Integrity. This requires research processes to be empowering by operationalising (walking the talk) five core values (ways of working): Equality, Respect, Responsibility, Reciprocity, and Survival and Protection. This session focuses largely on causes and consequences of health disparities among Canadian Indigenous Peoples, whose colonial histories and environmental justice challenges parallel those of Indigenous Australians. Both groups also experience distress from disruption of intimate links between traditional foods and cultural identity exacerbated by pollution and climate change. This discussion on ethics reflects on some key questions about transcultural research with Indigenous Peoples; e.g. Are we doing enough to promote the development of Indigenous researchers to lead Indigenous research with their own voices? Does cross-cultural environmental epidemiology require mixed methods for validity and effective knowledge translation? To what extent are we operationalising empowering values in the research we undertake as partners with these communities? What does that look like in practice? Are we measuring it? Should we be heeding the NHMRC Road Maps about research values and ethics for everyone we work with; not only Indigenous Peoples, but all who enable and participate in our research?

## 003.02H. Water Contaminants and their Effects

### **003.02.43. A Simple Probabilistic Modelling Tool to Estimate Children's Blood Lead Levels Resulting from High Variations of Daily Exposure through Drinking Water in Schools and Daycares**

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**Abstract:** BACKGROUND Spatiotemporal variations of lead (Pb) concentrations in drinking water ([Pb]DW) from schools and daycares can exceed an order of magnitude, with rare transient peaks possibly surpassing 1 mg/L. Available kinetic models that predict blood Pb levels (BLL) in exposed children hardly allow to account for variations of such magnitude and frequency. Therefore the aim of this study was to develop a simple tool that simulates the daily evolution of BLL in children exposed to ([Pb]DW) at school or daycare. METHODS Basic toxicokinetic equations were assembled to simulate BLL in a typical infant, toddler and child, respectively aged 0.5, 2 and 6 years. Modelling tool validation was done by comparing its predictions of BLL at steady-state with those obtained with the widely accepted Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). BLL were simulated for each typical individual assuming daily exposure to [Pb]DW over an academic year. Monte Carlo simulations were run to account for uncertainty and variability in [Pb]DW and model parameters. RESULTS The modelling tool predict steady-state BLL that fits ( $r^2 = 0.99$ ) IEUBK predictions for [Pb]DW in the range of 10 - 925  $\mu\text{g/L}$ . For a median [Pb]DW of 14  $\mu\text{g/L}$  (90th percentile = 168  $\mu\text{g/L}$ ), average annual BLL (median, 97.5th percentile) vary between 2.5 and 5.4  $\mu\text{g/dL}$  in infant and 1.9 and 3.9  $\mu\text{g/dL}$  in child. Correspondingly, maximum annual BLL are 3.4 and 7.8  $\mu\text{g/dL}$ , and 2.7 and 5.7  $\mu\text{g/dL}$ . The infant and child present BLL > 5  $\mu\text{g/dL}$  for up to respectively 191 and 24 days. Toddler's and infant's results are similar. CONCLUSIONS Exposure to [Pb]DW in schools and daycares may lead to increased BLL in children. Along with average level, the spatiotemporal nature of the exposure pattern is in itself an important determinant of BLL. Thus, better characterization, in schools and daycares, of [Pb]DW and children's drinking water consumption habits are required to evaluate their resulting risk of increased BLL.

### **003.02.44. Environmental Justice and Drinking Water Quality in U.S. Public Water Supplies**

Laurel Schaidler

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**Abstract:** Low-income and minority communities often face disproportionate burdens of exposure to pollution, and associations with race and ethnicity persist even after accounting for income. However, few studies have investigated links between drinking water quality and environmental justice. The goal of our study was to evaluate associations between drinking water quality and characteristics of public water supplies and demographics of the communities they serve. We compiled county-level demographic data from the U.S. Census Bureau and water system characteristics from U.S. EPA's Safe Drinking Water Information System. We obtained data for regulated contaminants (lead, TCE, trihalomethanes) in around 40,000 community water systems (CWSs) from individual state drinking water programs. Data for 17 unregulated contaminants were gathered from EPA's Unregulated Contaminant Monitoring Rule (UCMR) program (2013-2015), which included 4,650 CWSs serving 240 million people (every large supply serving >10,000 customers and a subset of small supplies). We found that percent of Hispanic residents and percent of residents living in urban areas were associated with increased likelihood of detection, or exceedance of health guidelines, for a variety of unregulated industrial (e.g., 1,4-dioxane, PFASs) and inorganic (e.g., chromium) contaminants and disinfection byproducts (e.g., chlorate). Percent Hispanic and percent urban residents were also associated with increased likelihood of at least one exceedance of a health guideline for the UCMR contaminants in our analysis. We further observed positive associations between wealth-related factors (lower rates of poverty, higher rates of homeownership) and industrial, inorganic, and disinfection-related UCMR contaminants. The relationships we identified between demographics and levels of unregulated contaminants are similar to those that we previously observed for nitrate; future work will extend these analyses to lead, TCE, and trihalomethanes.

### **O03.02.45. Estimating Exposure to 1,3-D in Drinking Water Using Groundwater Monitoring Data and PRZM-GW Modeling**

Ian van Wesenbeeck

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Abstract: 1,3-dichloropropene is a soil fumigant used for the control of nematodes in high valued fruit, nut and vegetable crops globally, and is applied at rates ranging from 50 to 350 kg/ha depending on the nematode pressure and crop type. Significant monitoring efforts have been undertaken over the past four decades by public and private institutions, given the widespread agricultural use and the environmental fate and metabolism data that suggest the potential for 1,3-dichloropropene (1,3-D) to leach to groundwater. The database of monitoring studies includes a survey conducted by various state agencies across the United States between 1980 and 1990, and analysis of ground water samples collected by US state and federal government agencies including the US EPA and the United States Geological Survey (USGS) since 1991. Also, tap water monitoring studies have been conducted in five major 1,3-D use regions in the United States, and in high-use regions in the EU and Canada. In total these studies report 1,3-D ground water monitoring results from hundreds of sites and thousands of water samples. The extensive ground water monitoring information developed through decades of monitoring supports the conclusion that soil fumigation with 1,3-D poses negligible risk from drinking water exposure. The lack of significant detections of 1,3-D from targeted monitoring studies is because of its high volatility and rapid degradation in most agricultural soils as well as the rapid degradation of 1,3-D and its metabolites in aerobic aquatic systems, and the rapid hydrolysis of 1,3-D in water. The water monitoring results are corroborated by PRZM-GW modeling when recently generated 1,3-D degradation half-lives in aerobic soil and water are used to parameterize the model. The results of both the modeling and monitoring can be used to assess human exposure and risk to 1,3-D via drinking water.

### **O03.02.46. Individual and Additive Disinfectant Byproducts in Community Drinking Water Systems and Associations with Colorectal and Bladder Cancer Incidence, Accounting for Population Served**

Alison Krajewski

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Abstract: Disinfectant byproducts (DBPs) haloacetic acids (HAA5) and total trihalomethanes (TTHM) used in community water systems (CWS) are potential bladder and colorectal carcinogens. Studies neglect to account for how exposures may differ within counties based on population served (PS) by CWS, which provides estimates of individual exposure. CWS concentration data for HAA5 and TTHM with PS were obtained for eight US states. These were summed to create additive DBP exposure and aggregated to the county-level to construct three cumulative county-level HAA5, TTHM, and additive DBP exposure metrics: unadjusted for PS; controlled for PS (as a covariate); and accounted for PS (concentration multiplied by proportion of PS by county population). Poisson regressions estimated incidence rate ratios (IRR) and 95% confidence intervals for associations between colorectal and bladder cancer and DBP, HAA5, and TTHM exposure tertiles, adjusting for potential confounders. For unadjusted DBP tertiles (<331 parts per billion (ppb), 331-732 ppb, >732ppb), the IRRs for colorectal cancer were 1.27 (1.22,1.32) and 1.58 (1.53,1.64) for tertiles 2-3, compared to <331 ppb, the lowest exposure category. For DBP tertiles controlled by PS, the IRRs were 1.27 (1.22,1.32) and 1.59 (1.54,1.65) for tertiles 2-3, compared to <331 ppb. After accounting for PS (<178 ppb, 178-502 ppb, >502 ppb), the IRRs were 0.92 (0.88,0.96) and 1.46 (1.41,1.51) for tertiles 2-3, compared to <178 ppb. Associations between colorectal cancer and HAA5 and TTHM tertiles were similar to the DBP tertiles. Associations between bladder cancer and HAA5, TTHM, and DBP tertiles were also similar to colorectal. Differing measures of PS by CWS in measured drinking water HAA5, TTHM, and DBP concentrations resulted in positive but varied associations to colorectal and bladder cancer. Thus, PS may need to be considered when developing drinking water exposure measures. This abstract does not reflect EPA policy.

### **003.02.47. Bladder Cancer Burden from Exposure to Trihalomethanes in Drinking Water in the European Union**

David Rojas-Rueda

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**Abstract:** **BACKGROUND and AIM:** Trihalomethanes (THMs) are prevalent chemicals in drinking water (DW). Exposure is through ingestion, inhalation and dermal absorption and has consistently been associated with increased bladder cancer (BC) risk. We assessed THMs levels in DW and estimated the burden of bladder cancer in the European Union (EU). **METHODS:** We obtained annual mean THM levels in municipal DW in the 28 EU countries in 2010-2017 through a standardized questionnaire and calculated the population-weighted EU mean. We used published THM levels in countries where THM data was not provided for further imputations. We estimated the attributable BC cases following the burden of disease approach. The dose-response function was obtained from the largest international pooled-analysis on THM exposure and BC and was used to estimate the odds ratio for each country, with an alternative exposure scenario of <5µg/L. We calculated the country annual number of attributable BC cases using incidence rates from GLOBOCAN. **RESULTS:** The amount of data, representativeness and accuracy was heterogeneous among countries. Mean THM level in drinking water in EU-28 was 11.9µg/L (SD 11.1), ranging from 0.0µg/L (Denmark) to 66.2µg/L (Cyprus). The EU 28 average population attributable fraction was 4.6%, and the maximum was 24% in Romania (95%CI 13-34) and 23% in Cyprus (95%CI 12-33). In total, 5,708 (95%CI 2,940-8,318) annual BC cases were attributable to THM exposure in the EU (ranging from 0 in Denmark to 1,498 in Spain). If THM levels in DW were reduced to the EU mean of 11.9 µg/L among countries above this level, 2,438 (95%CI 1,287-3,469) cases of BC could be avoided annually in the EU. **CONCLUSIONS:** Although the country mean THM levels were below the legal limit (100µg/L), the attributable BC burden and related costs are considerable and can be further lowered by improvements in the quality of DW, especially in countries with higher THM levels. **Funding:** FP7 EXPOSOMICS Project and CIBERESP.

### **O03.02.48. Disinfection By-Products in Public Drinking Water Systems in Newfoundland and Labrador (Canada): A Population-Based Study for Assessment of the Environmental Health Risks**

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**Abstract:** Presence of disinfection by-products (DBPs) in public drinking water and associated health risks, such as cancers are the contentious issues in the province of Newfoundland and Labrador (Canada). However, there is no large population level study showing any association between exposure to DBPs and water infrastructure and cancer risks. The objectives of the study were to explore any association between DBPs levels in public water supplies and cancer rates in individual communities and population of the communities. Community-based DBPs levels (trihalomethanes (THMs) and haloacetic acids (HAAs)) (2010-2016) were collected from the provincial government's website. The gastrointestinal and genitourinary cancer data were obtained from the provincial cancer registry. Out of total 362,670 population (310 communities with 336 public drinking water supplies), 60,913 (17%) were considered exposed to DBP exceedances. Odds ratios for the rates of gastrointestinal and genitourinary, and combined cancer and THMs and HAAs exceedances (combined) were 1.31 (95%CI: 1.20-1.43), 1.21 (95%CI: 1.02-1.44) and 1.31 (95%CI: 1.21-1.42) respectively. However, HAAs exposure has a stronger association (than THMs) with gastrointestinal, genitourinary, and combined cancer. Of the 260 systems servicing small communities (<1000 residents), 44 experienced either THMs or HAAs exceedances, and 92 experienced both. Of the 53 systems servicing medium communities (1000-3999 residents), 13 experienced either THMs or HAAs exceedances, and 18 experienced both. In contrast, of the 23 systems servicing large communities (>4000 residents), 2 experienced HAA exceedances, and 3 experienced both. 61.40% of the 272 systems that rely on a surface water source some form of DBPs exceedance. While only 7.58% of the 66 systems that rely on a ground water source experienced any type of DBPs exceedance. Smaller communities with low revenues experienced more exceedances of DBPs and higher prevalence of related cancers.

S03.02A. A Data and Research Platform for Healthy Cities: The Canadian Urban Environmental (CANUE) Health Research Consortium

**S03.02.01. The Canadian Urban Environmental Health Research Consortium (CANUE) - Enabling Collaborative Multi-Factor Environmental Health Research**

Jeffrey Brook

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Abstract: In 2015, the Canadian Institutes of Health Research (CIHR) called for a new national consortium that would bring together scientific and other expertise from a wide variety of disciplines and fields from academia, government, charities and industry, to focus on specific research priorities that can only be addressed through interdisciplinary and intersectoral research. This included developing a 'data and methodological hub' where environmental researchers could collaborate with cohorts and health researchers on focused health projects using innovative measurement models and 'analysis-ready' data. Responding to this call, the Canadian Urban Environmental Health Research Consortium (CANUE) was established and aims, through a coordinated program, to capitalize on Canada's growing big data capacity by facilitating the linkage of extensive geospatial exposure data to the wealth of established cohorts and administrative health data holdings (<http://canue.ca>). This presentation will provide an overview of CANUE's vision, structure, and related strategic plan, with a particular focus on successes and challenges during our first two years of operation and opportunities to advance environmental health research towards the goal of healthier urban populations.

## **S03.02.02. Developing an Environmental Exposure Data Platform for Urban Health Research**

Evan Seed

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**Abstract:** An important part of the Canadian Urban Environmental Health Research Consortium's (CANUE) mandate is developing an operational urban environmental exposure data platform in support of population-based health research. An effective data platform is viewed as key to breaking down some of the existing research silos in the environment and health field and enabling investigation of multiple and interacting environmental influences on population health. In this presentation, we focus on summarizing the types of exposure data in our platform and those we are currently working on, along with how we manage data access and provide user support with value-added content, and custom data processing and visualization tools. In the early stages of developing content for the data platform our efforts focused on integrating data from different national-scale data sources already in existence, many of which were publicly available with published supporting documentation. Continuing efforts focus on developing new data metrics and integrating the many regional and city-specific or, so-called long-tailed data that make up most urban data sets. Our early experience in developing an environmental exposure data platform has provided valuable lessons learned and guided the operation and user support provided by CANUE. In this context, we discuss the data curation process, including data discovery and content selection when presented with multiple datasets. The lessons learned are aimed at data managers that must decide on the value of the data as well as adding value to the data through the curation process. Finally, we discuss some of the emerging challenges in building, sustaining, and future-proofing an environmental exposure data platform for urban health research.

### **S03.02.03. Emerging Methods for Developing and Working with Urban Environmental Exposure Data**

Mahdi Shooshtari

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Abstract: The increasing availability of data with high spatial and temporal resolution, from satellites to street-level images, presents opportunities to make use of machine learning to derive and describe characteristics of the built environment regionally and nationally. Once produced, these metrics are themselves large data sets, with data on 800,000 locations over multiple months and years. This presentation will provide illustrative examples of CANUE's approaches and tools for working with very large datasets to produce metrics of urban form, useful for environmental health research. Google Earth Engine enables the global-scale monitoring and measurement of changes in the environment by curating and managing historical and ongoing satellite data; and providing an easy to use analytical platform for creating and implementing scripts and algorithms to process the data into useful metrics of environmental characteristics and their change over time. We present an overview of how we use this platform to produce metrics of greenness and local climate zone classifications. Google Street View and Open Street View images contain a range of information that can be used for mapping micro-scale urban features, such as building and vegetation types. Here we describe machine learning approaches used by CANUE to identify features of interest and discuss some of the inherent strengths and weaknesses. The final exposure metrics held in the CANUE platform are large datasets. A single metric of annual average temperature is available for each of 800,000 postal codes, in each year of 1984-2016 inclusive, and monthly versions increase this volume twelve-fold. In other cases, the underlying data begin at an hourly resolution. Here we describe script-based tools for summarizing these data into aggregated exposures over time based on residential history, and into temporal trends by postal code.

#### **S03.02.04. Spatial and Temporal Changes in Urban Environmental Exposures: Practical Examples**

Dany Doiron

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Abstract: Since its launch, CANUE has assembled a dozen nationally standardized urban exposure metrics and is regularly integrating new regional and national datasets into its data holdings. These environmental exposure datasets can support comprehensive analyses of the spatial and temporal distribution of multiple exposures in large populations. This presentation will give an overview of selected exposure metrics currently held and disseminated by CANUE and their distribution in space and time. Spatial differences and temporal changes in area-level environmental exposures from the 1980s to today in Canada's three largest Census Metropolitan Areas (Toronto, Montreal, Vancouver) will be highlighted. For example, trends in postal code-level neighbourhood greenness over a 30-year period will be shown, with examples of areas with particularly large fluctuations. Changes in population-level exposure to air pollutants (nitrogen dioxide, ozone and fine particulates) and comparisons of walkability scores in these three cities will also be shown, highlighting areas favouring active living. The public health relevance of trends and differences in exposure metrics over time and space will be emphasized throughout.

### **S03.02.05. Emerging Evidence on Multi-Factor Associations between Urban Exposures and Health Outcomes: Practical Examples**

Dan Crouse

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**Abstract:** This presentation will showcase exemplary studies that have integrated CANUE exposure data with several large, Canadian, population-based health datasets. The first case study focuses on results from a large cohort study in which estimates of exposures to fine particulate matter (PM<sub>2.5</sub>), ozone, and nitrogen dioxide were assigned to subjects across Canada in the 1991 Canadian Census Health and Environment Cohort (CanCHEC). We examined associations between cause-specific mortality and exposure to these pollutants using single and multi-pollutant models. Our results suggest that exposure to PM<sub>2.5</sub> alone does not fully explain the risk of mortality associated with exposure to ambient pollution. A second case study presents results from a study investigating associations between risk of mortality and living in greener areas of Canada's 30 largest cities among subjects in the 2001 CanCHEC. Here, we used satellite-derived estimates of greenness, and adjusted our survival models for exposures to ambient air pollution (in addition to many personal and contextual characteristics). We found that increased amounts of residential greenness were associated with reduced risks of dying from several common causes of death. We found more protective effects among men (compared to women), and among those with higher incomes and with higher levels of education. Finally, a third case study describes an ongoing study in which we have linked data related to weather, ambient air pollution, and a community-level deprivation index to patients diagnosed with multiple sclerosis (MS) through the Canadian Chronic Disease Surveillance System and living in New Brunswick. Here we are exploring associations between several environmental exposures and spatial and temporal patterns of MS incidence.

## S03.02B. Empowering Vital Environmental Health and Exposure Research to Address Disasters and Emerging Threats

### S03.02.07. Importance of Exposure and Health Disaster Research

Linda Birnbaum

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**Abstract:** Responses to various disasters including the World Trade Center attack, Great Eastern Japan Earthquake, Gulf Oil Spill, Ebola and Zika outbreaks, Lac-Mégantic rail disaster, and recent hurricanes and wildfires have revealed the dire need for improved ability to perform rapid data collection and research for such events. In 2013, leaders from NIH, CDC, and HHS, noted that "the knowledge that is generated through well-designed, effectively executed research in anticipation of, in the midst of, and after an emergency is critical to our future capacity to better achieve the overarching goals of preparedness and response: preventing injury, illness, disability, and death and supporting recovery." While much has been done to improve the life-saving response for public health emergencies, these events have also revealed notable gaps in our ability to develop, coordinate, and implement needed scientific research in response to a disaster. It took 11 months to begin a longitudinal health study of exposed workers after the Gulf Oil spill. Such delays adversely affect the ability to identify participants or gather vital information to determine disaster-related risk factors such as resiliency, health outcomes related to exposures or other stressors, or efficacy of various response activities. Critical data are lost if not collected in a timely, systematic, and scientifically rigorous manner through coordinated interdisciplinary efforts with multiple stakeholders, including impacted communities. In response, the NIH Disaster Research Response Program was created to facilitate time critical data collection and research into national response and recovery efforts. Together with Canada and Japan, progress is being made to overcome some of the challenges and advance disaster research capabilities including availability of research protocols, IRB review processes, coordination among government agencies, and engagement of academic, public health, and community stakeholders.

### **S03.02.08. Applied Epidemiology and Exposure Challenges in Response to the Gulf Oil Spill**

Richard Kwok

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Abstract: Each environmental or man-made disaster presents unique challenges for studying potential health consequences. Nonetheless, valuable lessons from studying a single disaster can inform approaches following other disasters. The 2010 Gulf of Mexico Deepwater Horizon disaster created the largest marine oil spill in history. Individuals who worked on the clean-up of the spill were exposed to toxicants, stressors, and other environmental factors that could affect health. In 2011, NIEHS initiated The Gulf STUDY (Gulf Long-term Follow-up Study) to investigate a wide range of chemical and non-chemical exposures and potential physical and mental health effects. Study participants participated in clean-up or attended worker safety training. Cohort enrollment involved telephone interviews, followed by a home exam for Gulf coast residents. Most participants enrolled long after active clean-up had ended. The findings from the study may inform public health responses in Gulf communities and/or responses to future oil spills. This discussion will highlight the issues and challenges of gathering information quickly to inform the design of a large-scale prospective cohort study of over 32,000 individuals involved in the 2010 Gulf Oil Spill response and clean-up efforts. Such challenges include: Administrative and ethical approvals, uncertainty due to lack of coordination between response and research organizations, utilizing data collected for non-research purposes, enrolling large numbers of participants from impacted communities, and conducting complex clinical measurements in atypical environments, while at the same time striving to ensure high quality data, transparency, and communications.

### **S03.02.09. Development of the NIH Disaster Research Response (DR2) Program and Ongoing Efforts in the U.S.A.**

Aubrey Miller

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Abstract: Responses to various disasters and emerging threats have revealed the dire need for improved ability to perform rapid data collection and research for such events. As such, the National Institutes of Health Disaster Research Response Program (DR2) was created to build and promote tools, processes, and relationships to collect vital exposure and health information in response to environmental disasters. The DR2 Program, a collaborative effort between the National Institute for Environmental Health Sciences and the National Library of Medicine, reduces the time required to deploy a public health research response after disasters by providing access to over 345 online publicly available data collection tools and information. Metadata was also developed to help researchers review and understand the utility of the various tools for differing situations. Additionally, a novel human subject reviewed protocol that can be rapidly modified and used for future disaster situations has been developed. This protocol includes the ability to perform medical testing and collection of exposure data, including biospecimens. National workshops, large-scale tabletop exercises, and new networks linking academia, public health officials, and impacted communities have also been created to test initiatives, address ethical considerations and Institutional Review Board issues, and to implement environmental health and exposure research in response to emergencies. As such, the research community is now poised to begin moving into a new era of strategic science as part of disaster response efforts. This presentation will facilitate understanding of common barriers in disaster research and strengthen awareness of efforts to improve our collective capacity to perform time critical human health and exposure assessments to support decision-making and improve preparedness, response, and recovery efforts.

### **S03.02.10. Disaster Response Research Development in Japan**

Shoji Nakayama

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Abstract: Japan is a country of natural disasters and many lessons have been learnt in the past. The Disaster Medical Assistant Team (DMAT) system is one of those. After the 11 March 2011 Great Eastern Japan Earthquake and Tsunami, Japan experienced unprecedented disturbance of people's life including destruction of infrastructures, mass evacuation and collapse of communities. Everything went mess from immediate shortage of life supporting facilities to loss of future prospects. The importance of the unified command system is also a lesson learned from the past disasters such as the Kobe earthquake. However, there is still a gap in tools for decision makers to acquire timely information about public health status of affected areas. For example, there are no standardised tools to evaluate the consequences of long-term evacuation on emotional and physical health. The lack of such epidemiological instruments makes it difficult to perform evidence based public health. Absence of such tools may also have hampered the participation of public health specialists into disaster response teams. In Japan, the government moved to establish a public health response team, namely Disaster Health Emergency Assistance Team or DHEAT, in order to quickly provide prompt public health services during and after the disaster. To add an environmental component to such an effort, the National Institute for Environmental Studies started a programme to implement epidemiological tools that can be readily used from immediately after the disaster onset to decades long recovery periods for assessing general and specific environmental exposures and their effects on affected people. This presentation will focus on the Japanese endeavour to develop disaster epidemiology tools and its collaborative works with the US National Institute of Environmental Health Sciences.

### **S03.02.11. Disaster Research Response Development in Canada**

Tom Kosatsky

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Abstract: The 2016 Alberta wildfires, which destroyed entire neighbourhoods of urban Fort McMurray and the 2013 Lac-Mégantic, Québec train derailment and explosion illustrate that Canadian communities are not immune to environmental public health (EPH) disasters. Disasters expose the population, responders and volunteers to a range of contaminants and stressors, which may harm physical and mental health. When disasters strike, the initial focus is on life saving interventions such as clinical care and measures aiming at minimizing population exposure including evacuation, sheltering in place and do-not-consume advisories. Afterward, attention shifts toward community re-entry, rehabilitation and health studies to address potential delayed and long-term health effects. Exposure science and environmental epidemiology resources can play a vital role in supporting response authorities to reduce the health risks from the release of hazardous chemicals. They may contribute to the timely identification, determination of concentrations and dispersion of released substances, designing questionnaires and initiating registries, and evaluating the value of biological sampling. Further, EPH disasters typically offer a brief window of time to collect ephemeral exposure data, biospecimens and to start scientific research that could improve both health outcomes and capabilities for future response. This discussion will highlight the efforts of the Canadian Disaster Research Response (CanDR2) Steering Committee to develop a Pan-Canadian framework aiming at enhancing the integration of EPH scientific and research assets into disaster management. Three EPH focus areas will be presented: (1) Establishing a disaster response community of practice or network (2) Generating and transferring disaster knowledge, and (3) Enhancing timely data sharing, sample collection and health research execution.

## S03.02C. Environmental Justice and Women's Health

### **S03.02.13. Digital Daily Logs: A Novel Method for Collecting Acute Health Symptoms in an Environmental Justice Neighborhood Adjacent to Active Oil Drilling**

Bhavna Shamasunder

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**Abstract:** Los Angeles is the largest urban oil field in the United States and one of the most oil rich basin in the world. In low-income neighborhoods of color with cumulative vulnerabilities (such as greater linguistic isolation and higher percentages of renters), active drilling occurs much closer to homes, schools, playgrounds, and other sensitive land uses with fewer protections such as emissions control equipment and covered fields. In collaboration with a community-based network of promotoras, (community health workers), we assessed the ability to collect daily acute symptoms and well-being information using a phone-based platform among predominantly Latino residents in South Los Angeles living within 500m of an oil well. Here, we describe the process to develop a bilingual daily digital health log. Using a text messaging system, we aimed to pilot a mixed methods approach to log information about health and social stressors. Our research was informed by a prior community health survey that supported community research capacity building within promotora networks (Shamasunder et al, 2018). 113 people participated in the 7-day study with a 77% response rate (n=87). 76% of study respondents were women. In the preliminary analysis, we coded qualitative reports on stress from the daily logs among participants. Responses to digital daily logs indicate responses within individuals change daily. Women note a greater number and variety of stressors. Stress was associated with reports of headaches, anxiety, fatigue, work, and lack of work. Residents' concerns over children's schooling was a top concern. Social stressors may make residents more vulnerable to impacts of pollution. Headaches, for example, have been associated with oil extraction, and were ascribed by residents to other life stresses. This novel approach can help facilitate collection of symptoms and stress data in an environmental justice community.

### **S03.02.14. The COSECHA Study: Youth Peer-To-Peer Research on Pesticide Exposure in a Farmworker Community**

Kim Harley

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**Abstract:** Background: Seven million pounds of pesticides identified as possible carcinogens or endocrine disruptors are applied annually in California, but there is little data on how adolescent girls in agricultural communities may be exposed. Methods: We conducted a youth empowerment project to measure pesticide exposure among 100 14-16 year old Latina girls living in the agricultural Salinas Valley, CA. Pesticide concentrations were measured in silicone wristbands worn by participants for one week and in house dust. High school students (N=10) hired as youth research assistants collected the data and were engaged in study design, implementation, and dissemination. Results: Compounds detected in wristbands and dust included agricultural-use, residential-use, and now-banned pesticides. Commonly detected pesticides in house dust were permethrin, carbaryl, chlorothalonil, and fipronil. Fipronil compounds and permethrin were also widely detected in wristbands. Living within 100m of an agricultural field was associated with higher concentrations of dacthal and permethrin in wristbands and higher permethrin in house dust. Pesticide products in the home and using an exterminator were associated with higher permethrin in wristbands and dust. Participants with door mats in their home entryway had significantly lower concentrations of cypermethrin, permethrin, fipronil sulfide, and DDE in their wristbands and lower concentrations of cypermethrin in their dust. Discussion: This youth-led study characterizes pesticide exposure to adolescent Latina girls and suggests methods for reducing exposure. The youth researchers have developed innovative educational messaging, including puppet shows, videos, and radio dramas; taught residents to access information about local pesticides use; and plan to distribute door mats and develop educational murals to share results and minimize future exposures.

### **S03.02.15. Community- and Discovery-Driven Exposure Science in the Women Firefighter Biomonitoring Collaborative**

Rachel Morello-Frosch

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Abstract: Occupational studies indicate that firefighters are at higher risk for different types of cancers than the general population, and concern has mounted about elevated rates of premenopausal breast cancer among women firefighters. The Women Firefighters Biomonitoring Collaborative (WFBC) is a community-based participatory research project analyzing exposures to environmental chemicals linked to breast cancer among female firefighters in San Francisco (SF) compared to non-firefighters. As scientific partners in the WFBC, women firefighters have been involved in study design, data collection, and results communication. Between 2013 and 2014 we recruited 86 women firefighters and 84 office workers employed in San Francisco, conducted an exposure assessment interview, and collected blood samples. We conducted targeted analysis for 12 perfluoroalkyl substances (PFAS) using liquid chromatography-tandem mass spectrometry. We detected seven compounds in over 70% of participants at levels above the level of detection (LOD 0.02-0.05 ng/ml), five of which were detected in 98 -100% of participants. Multivariate models showed that firefighters had a 1.53 and 2.19 times higher concentration of PFNA and PFHxS respectively, compared to non-firefighters. Among firefighters only, multivariate models showed increased concentration of PFNA, PFOA, PFOS and PFUnDA for firefighters aged 50 years or older, and higher PFOA levels among firefighters who reported ever using firefighting foam. Additionally, PFHxS levels were higher among those who "rarely" used personal protective equipment (PPE) compared to those who reported "always/often" using PPE. Our results indicate that women firefighters have higher levels of some PFAS compared to office workers, and that these exposures may be associated with firefighting foam and PPE use. Further research is needed to understand the health implications, particularly for breast cancer risk, of these exposures.

### **S03.02.16. Air Pollution and Gynecologic Disease Outcomes: Infertility, Menstrual Irregularity, Uterine Fibroids, and Endometriosis**

Jaime Hart

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Abstract: While issues of environmental justice have highlighted populations at high risk of adverse health outcomes due to air pollution, chemical exposures, and land use, how these disparate exposures might uniquely impact women's health is an area of emerging research interests. Women may be particularly vulnerable in different ways than men; in that, socially- and culturally-patterned exposures may lead to different exposure patterns in women. Sex differences in biological processes can also play a role in how chemical exposures could differentially impact the health of women compared to men. Further exacerbating these differences are how sex intersects with race, class, or gender to impact both environmental exposures and downstream biological effects on disease outcomes in women. This interaction between social, environmental, and biological factors may place vulnerable subpopulations of women, such as Hispanic or African-American women, at a disadvantage with respect to disease risk. We will highlight the growing body of research of the effects of air pollution on female reproductive outcomes and infertility, and the implications of these findings among vulnerable populations.

### **S03.02.17. Environmental Phthalates Exposure and Measures of Uterine Fibroid Size among a Racially Diverse Population of Premenopausal Women**

Ami Zota

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**Abstract:** Background. Etiology of uterine leiomyoma (fibroids) is poorly understood. Endocrine disruptors, such as phthalates, may contribute to fibroid pathobiology because ovarian hormones are critical to fibroid growth. Objectives. We examined the association between phthalates exposure and two measures of fibroid size: diameter of largest fibroid and uterine volume. Study Design. We conducted a cross-sectional study of 61 premenopausal women undergoing surgery for their fibroids between 2014-2017 in an urban academic hospital in Washington DC. Spot urine samples were collected during a pre-operative clinical visit and analyzed for 14 phthalate metabolites and two non-phthalate plasticizer metabolites using mass spectrometry. Information on fibroid and uterine characteristics was obtained from MRI and/or ultrasound imaging. We examined associations with individual biomarkers, metabolite sums by parent compounds, and a potency-weighted sum of antiandrogenic phthalates ( $\Sigma$ androgen-disruptor). Size of the largest fibroid and uterine volume were modeled as dichotomous outcomes (divided at the median) using logistic regression adjusting for age, race/ethnicity, BMI, and time since diagnosis. Results. The majority of the sample was African American (63.9%), overweight or obese (75.1%), and had completed college or graduate school (68.3%). In multivariate models, women with higher concentrations of di(2-ethylhexyl) phthalate (DEHP) and diisononyl phthalate (DiNP) metabolites, and  $\Sigma$ androgen-disruptors had significantly greater uterine volumes compared to women with lower concentrations.  $\Sigma$ DEHP metabolites and  $\Sigma$ DiNP metabolites were associated with 3.05 (95% CI 1.08-8.63) and 1.87 (95% CI 1.07, 3.29) increased odds of greater uterine volume, respectively. Conclusions. In this preliminary study, exposure to some phthalates was associated with larger uterine volume, a marker of disease severity and fibroid growth. Larger, prospective studies are needed to confirm these relationships.

### **S03.02.18. Urinary Paraben Concentrations and Pregnancy Glucose Levels among Women from a Fertility Clinic**

Tamarra James-Todd

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**Abstract:** Background: A number of endocrine disrupting chemicals (EDC) are associated with gestational diabetes (GDM) risk factors. Few studies, however, have investigated the association between pregnancy exposure to parabens, a class of widely used EDCs, and pregnancy glucose levels—a risk factor for GDM. Furthermore, little is known about this association in subfertile women—a group at high risk of GDM. Methods: Using a prospective cohort study, 241 women from the Environment and Reproductive Health (EARTH) Study had data available on 1st and/or 2nd trimester urinary methyl- (MP), butyl- (BP), and propyl-paraben (PP) concentrations, as well as late 2nd trimester glucose levels from the GDM screening test. Trimester-specific associations between MP, BP, PP, and pregnancy glucose levels, were first evaluated in separate statistical models. Paraben mixtures were also assessed using mutual adjustment, as well as Bayesian Kernel Machine Regression (BKMR), a recently proposed method for chemical mixtures that flexibly models the joint effect of chemicals in a non-parametric fashion. Results: When assessed individually, we observed positive associations between BP at both 1st and 2nd trimesters, and late 2nd trimester glucose levels (e.g comparing the 4th and 1st quartile, respectively:  $\beta=7.8$  mg/dL; 95% CI:-2.9, 18.6;  $\beta=10.6$  mg/dL; 95% CI:0.7, 20.5). When investigating paraben mixtures, we found a positive association between 1st trimester BP and glucose ( $\beta =10.2$  mg/dL; 95% CI:0, 20.4) and a suggestive negative association between 1st trimester PP and glucose ( $\beta =-13.9$  mg/dL; 95% CI: -30.4, 2.6). We observed no evidence of interaction among parabens. Conclusion: We found concentrations of BP when assessed individually and as a mixture to be positively associated with glucose levels. Given the wide-spread use of parabens in consumer products, certain parabens may dysregulate glucose levels during pregnancy, with implications for GDM risk.

S03.02D. Omics in Environmental Epidemiology for Understanding Current Environmental Health Issues

**S03.02.19. Using Molecular -Omics in Environmental Epidemiology to Gain Unique Insights into Environmental Health**

Todd Everson

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**Abstract:** The incorporation of molecular -omics data into environmental epidemiology allows environmental health researchers to answer novel questions about how our environment influences health and disease. Although molecular data have been consistently utilized in experimental biological research, the the rapid growth and development of -omics technologies is making genomics, epigenomics, transcriptomics, proteomics, metabolomics and microbiomics increasingly accessible to epidemiologic research. These technologies allow for the interrogation of hundreds of thousands to millions of molecular features in a highly reproducible and cost-effective fashion in human samples, and the incorporation of these tools into environmental epidemiology has enabled the field to investigate how the environment impacts human health in novel ways. In turn, these features can form useful biomarkers of exposure-response relationships, inform us about toxic mechanisms and modes of action, and contribute to causal reasoning. However, incorporating these types of data into epidemiologic research comes with many challenges, including having to consider tissue-specific responses to stressors, dealing with technical artifacts, how and whether to adjust for tissue heterogeneity, and limiting the possibility of false positives while allowing for the discovery of true positive findings. I will present an overview what genomics, epigenomics, transcriptomics, proteomics, metabolomics and microbiomics can add to environmental health research, and recent advancements in the field to deal with the potential challenges of doing so.

## **S03.02.20. Assessing the Influence of in Utero Co-Pollutant Exposures on Transcriptomic Networks and Birth Outcomes**

Maya Deyssenroth

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Abstract: Multiple studies have linked intrauterine exposures to birth outcomes. However, inconsistencies in the literature persist. While heterogeneity in study conditions likely play a role, the discrepancy in reported findings may also reflect a focus on assessing the isolated effect of individual pollutants. Such methods fail to account for the presence of co-pollutants that may alter the activity of the specific exposure under consideration. The molecular pathways through which environmental exposures exert their effects have not been clearly delineated. However, it is suggested that in utero toxicant exposures may induce aberrations in processes mediated by the placenta, the organ overseeing appropriate fetal development. Alterations in the expression and methylation of several placental loci, including genes involved in nutrient transport, endocrine signaling and imprinting, have been linked to birth outcomes. However, similar to studies linking pollutants to birth outcomes, molecular biomarker studies largely focus on univariate associations between individual genes and health effects. High-throughput assessments of environmental exposures and molecular markers are becoming increasingly available to better capture the relationship between toxicant exposures, affected molecular processes and health effects within an environmental epidemiology context. To take advantage of this rich resource, however, methodologies need to be developed that not only account for the complexity but also facilitate integration across datasets. Here, we motivate the application of novel statistical and bioinformatics-based approaches, including environmental mixture modeling methods and gene coexpression networks, to gain insight into the inter-relationship among intrauterine trace metal exposure, placental gene activity and fetal growth.

### **S03.02.21. The Epigenome and In-Utero Environmental Exposures**

Mariona Bustamante

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Abstract: The epigenome is defined as the network of chemical marks that regulate the function of the genome. The epigenome receives the signals from the genome and from the environment to produce a homeostatic response, and therefore it is dynamic and tissue specific. DNA methylation is the epigenetic mark most extensively studied in epidemiological designs. Environmental insults can leave a fingerprint on DNA methylation, particularly those that occur prenatally, which might persist and be connected to disease later in life. We will highlight recent findings from the Pregnancy and Childhood Epigenetics (PACE) consortium and the HELIX (Human Early Life Exposome) project on maternal tobacco smoking during pregnancy and other environmental factors to illustrate the link between in-utero environmental exposures, DNA methylation and disease. Maternal smoking during pregnancy has been associated with differential methylation at thousands of CpGs in cord blood, with some of them persisting into childhood, and this signature was successfully used to develop a biomarker of exposure. Interpreting the results from epigenetic epidemiology studies can be complicated due to the tissue specificity of epigenetic responses, and the complex relationship between DNA methylation and gene expression. For instance, we observed that maternal smoking sensitive CpGs in cord blood and placenta are markedly different, likely related to the unique ways through which these two tissues process and respond to toxic exposures. The challenges of the epigenomics in environmental health research for the next years will be discussed, including: sample size and collaboration in consortia, resolution of current DNA methylation arrays, assessment of other epigenetic marks, access to the target tissue, controlling for cellular heterogeneity, analysis of longitudinal data, and integration of different molecular layers to interpret findings.

## **S03.02.22. The Exposome and the Developmental Origins of Lifelong Health: Pre-, Peri- and Postnatal Microbiome & Metabolome Development**

Juliette Madan

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Abstract: The roles of human-associated microbial communities in health are appreciated, but we lack a mechanistic understanding of the differences between health promoting or dysbiotic/detrimental microbial communities and how the microbiome develops over time. Large scale epidemiological studies of environmental toxicants and their impact on human health benefit from thorough investigation of the bidirectional relationship between toxicants and the human microbiome/metabolome. Ultimately, the effects of microbial communities on health outcomes is particularly evident in the pre-, peri-/post and neonatal period during the critical window of microbial training of the developing immune system. Data generated by us and others indicate that microbial community development and metabolism can be influenced by coexisting microbes in often unexpected ways, and we hypothesize that these networks of microbial metabolic interactions drive community development and function. In our Children's Center at Dartmouth, we combine targeted microbial sequencing, metagenomics and metabolomics analyses, computational methods, and laboratory-based studies to identify microbial community structures over time, and microbe-produced metabolites that influence community development and stability. Our group investigates the relationships between exposures (e.g. environmental toxicants such as arsenic, dietary exposures, medications/antibiotics, delivery mode), the developing microbiome and metabolome in pregnancy, infancy and early childhood, and associations with health outcomes in a large molecular epidemiological study of 2,000 mother-infant dyads (4,000 subjects), the New Hampshire Birth Cohort Study. Our long-term goal is to rigorously test associations between microbiome development, community metabolism and host physiology, and to apply this knowledge to the discovery of strategies for health promotion.

### **S03.02.23. Metabolomics, Complex Exposures, and Multi-Omics Integration**

Shuzhao Li

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Abstract: The revolutionary capability of modern mass spectrometry enables ultra high-resolution metabolomics, which embodies the 2nd golden age of biochemistry since the delineation of major metabolic pathways. These metabolomics data capture endogenous metabolites, dietary intake, pharmaceutical drugs and environmental pollutants, and serve as a key middle layer between genome and environment. Using metabolome-wide association studies, we start to gain mechanistic insights of health impact by environmental exposure. Our mummichog algorithm further brings untargeted metabolomics to pathway and network interpretation. We will present examples on environmental epidemiology, disease studies and multi-omics integration.

## S03.02E. Why is My Sensor Not Working? - Making Sense of Sensor Technologies for Environmental Exposure and Health Studies

### **S03.02.25. Moving Towards an Adaptable Laboratory and Field Testing Protocol for Evaluating Sensor Performance**

Benjamin Barratt

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**Abstract:** The potential for sensors to revolutionize environmental assessment and public engagement has been recognized for some time, however, initial enthusiasm has been blunted by disappointing outcomes, often arising from inappropriate use and/or unrealistic expectations. To move forward, industry, academia and the public require a transferrable "quality mark" for sensor performance indicating a technology's applicability for use in various settings. The aim of this symposium workshop is to stimulate discussion and ideas to ensure more robust outcomes in sensor deployment scenarios. This opening presentation will set the scene by describing the requirements for the development of an internationally recognizable laboratory and field testing protocol for environmental sensors. It will include a review of ongoing initiatives in Europe and North America, including their strengths and weaknesses. The London Air Quality Network Sensor Evaluation Protocol (LAQN-SEP) is one example of a protocol developed to meet the needs of research and citizen science in London. It incorporates a series of defined tests utilizing fixed reference-grade instruments and well-characterized portable monitors, allowing field evaluation of sensor performance in stationary and mobile deployments, including microenvironments. The LAQN-SEP is now being extended to allow independent testing of sensors by manufacturers through secure access to testing infrastructure. This will allow rapid and repeat evaluation against high cost reference monitors with minimal overhead from the host organization. While environmental sensor testing protocols are being developed in many countries, many of these are based on existing protocols developed for hardware-based systems. There is the risk that these will be too inflexible or costly to react to the rapidly changing world of software-based systems. Through discussion between a wide range of users and developers, it is hoped that these pitfalls will be avoided.

### **S03.02.26. Are Low-Cost Sensors Ready for Prime Time? The Case of Mobile Monitoring**

Joshua Apte

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**Abstract:** Lower-cost air pollution sensors offer the potential to dramatically increase the density with which air quality is monitored, thereby filling critical gaps in exposure assessment. One possible application for low-cost sensors is their use for mapping air quality when mounted on fleet vehicles such as taxis, buses, or delivery vans. However, mobile sensor deployments present unique challenges. When measuring on a rapidly moving platform, a high sampling rate ( $\sim 1$  Hz) may be desirable to capture spatial variability in air quality. Additional measurement challenges include vibration, wind, and frequent shifts in concentration, temperature, and humidity. We conduct a simulation study to consider the extent to which common performance limitations of available sensors might present challenges for mobile monitoring. As a starting point, we employ a rich dataset of measurements collected using two Google Street View cars specially equipped with reference grade instruments to measure NO, NO<sub>2</sub>, and black carbon. The measurements consist of  $\sim 2$  y of repeated observations (20-50 times) on every street in a 30 km<sup>2</sup> of Oakland, CA. To simulate the performance limitations of lower-cost sensors, we systematically degrade the performance of reference grade measurements and compare the resulting air quality maps to the reference dataset. We consider the following performance degradation scenarios: reduced sampling frequency, increased averaging time, randomly distributed noise (reduced precision), and serially correlated errors (drift). Our simulations suggest that an air quality mapping approach with repeated observations can be surprisingly robust to these common types of measurement degradation.

### **S03.02.27. Ensuring Trustworthy Data for Communities Engaged in Environmental Sensing**

John Volckens

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**Abstract:** The recent proliferation of low-cost air quality sensors has sparked much interest among scientists, policymakers, and the general public. These sensors have enabled measurements at unprecedented spatial and temporal scales, which, in turn, has led to the creation of distributed networks to support both traditional research and community-based studies. Low-cost sensors also show promise for the emerging field of citizen-science and for application in resource-limited environments. With these exciting prospects, however, come challenges of sensor performance, reliability, data management, and communications/messaging to various stakeholders. This presentation will summarize our research on the development, evaluation, and application of sampling and sensor technologies for exposure and health research. Our group has pioneered the development of several devices for assessing human exposure to particulate matter air pollution (i.e., the UPAS, AMAS, OAS instruments). We have deployed these technologies for epidemiologic research on children and adults, for citizen-science research at the individual and community level, and for stakeholder-driven assessment of air quality in distinct microenvironments. This presentation will summarize prospects and pitfalls associated with real-time and time-integrated data collection, with the choice of low-cost vs. reference-grade measurement devices, with data management/quality (and data protection), and with communicating and working with members of the community (i.e., non-scientists). We will conclude with some discussion on the topic of matching the measurement to the research question of interest and on the potential for disconnects/misalignment between the exposure and epidemiologic research communities.

## **S03.02.28. Strategies for Sensor Deployment to Reduce Bias in Environmental Exposure and Health Studies**

Jill Baumgartner

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Abstract: Environmental sensing technologies are rapidly advancing. In particular, low-cost air pollutant measurement and health tracking techniques are emerging and existing techniques are becoming more compact and adapted for field deployment. However, field implementation of environmental sensors has proven challenging across many settings, study sizes and study designs, particularly when multiple stakeholder groups are involved in data collection and their interpretation. The proposed presentation will be the fourth in a symposium on the selection and use of sensing technologies for exposure and health studies and related challenges. This presentation will proceed sessions on sensor performance evaluation and validation processes, and aim to present recent examples of novel use of low-cost sensors for environmental intervention and policy evaluation and epidemiologic research. I will incorporate recent examples from my groups work on the integration of both models and sensors in health and exposure studies of household and ambient air pollution. This presentation will aim to facilitate discussion among symposium attendees about strategies to scale up environmental sensing for application in environmental health studies. In particular it will highlight the measurements trade-offs for researchers to consider in sensor selection and implementation, and the implications for measurement error and other types of bias in health studies.

### **S03.02.29. Sensor Selection and Scaling Up Mobile Monitoring for High-Resolution Mapping of Community Air Quality: Design Considerations in the MOV-UP Airport Ultrafine Particle Study**

Edmund Seto

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Abstract: As novel environmental monitoring and exposure sensing approaches evolve, there is still the need to match the air quality concerns of communities with appropriate measurements. Designing an appropriate measurement approach for exposure studies requires identifying the sources of greatest concern, the set of pollutants that best characterize these sources, and sampling in manner that quantifies variations in concentrations in space and time. Recently, for the new Mobile Observations of Ultrafine Particles (MOV-UP) study, a sampling plan was designed to characterize ultrafine particle levels in communities near the SeaTac International Airport in Seattle, WA. Because of the need to cover a large area of approximately 250 km<sup>2</sup> with a limited instrument and staffing budget within the timeframe of a year, a mobile monitoring approach was chosen, in which two instrumented vehicles would collect ultrafine particle measurements along local roads that transect the flight paths of the airport. Mobile monitoring would allow coverage of the large area with a relatively small number of high-end ultrafine particle counters. In addition to measuring ultrafine particle concentrations for the MOV-UP study, there was also a need to distinguish between ultrafines sourced from roadway traffic versus those from aircraft. GPS data were used to identify driving on major roadways, and were supplemented by additional measurements of ultrafine particle size and black carbon levels to help discriminate between roadway and aircraft sources. A principal component analysis (PCA) yielded multivariate eigenvalues representative of the different sources of concern. Also, relating flight patterns with wind patterns may also help to identify ultrafine particle levels attributable to aircraft.

### **S03.02.30. A One-Dollar Passive Sensor for Black Carbon Monitoring: Capturing the Blackening**

Julian Marshall

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**Abstract:** Background Black carbon (BC) is a major constituent of fine particulate matter (PM<sub>2.5</sub>), which is the largest environmental health risk worldwide, according to the Global Burden of Disease. BC is also associated with climate change because it is light-absorbing. Low-cost and ultra-low-cost sensors offer the potential to radically increase the quantity of environmental data (relative to using conventional sensors), though potentially at lower quality per datum. Research question Can an ultra-low-cost sensor (marginal cost per new measurement: under ten U.S. dollars) reliably measure long-term average indoor BC concentrations? Methods We designed and prototyped several ultra-low-cost sensors, and tested them in a laboratory and in the field in India. Like most BC sensors, our approach is based on the blackening of a white surface, which causes a change in the reflectance / absorbance of light incident to that surface. The resulting information reflects a time-integrated measure. We selected only designs that can be left in place for weeks or months, thereby shedding light on long-term average conditions. Data analyses test for reproducibility and limit of detection Results We employed two ultra-low-cost designs: one active, one passive. Maintenance is not required for the passive sampler and is minimal for the active sampler. Preliminary results indicate a high degree of reproducibility (correlation among duplicate samples: >0.9) and a limit of detection that would correspond to ~ a few weeks in a highly polluted environment (e.g., in a low-income household that burns solid fuels).

### **S03.02.31. The Application of Sensors in Air Quality and Health Studies in China**

Mei Zheng

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Abstract: Air pollution in the Northern China has received great attention in recent years, primarily due to frequent haze in fall and winter. To understand the sources, formation mechanisms and health impacts, various techniques have been applied including speciation of fine particles at ground station, vertical profiles of pollutants, satellite retrieval of aerosol etc. In recent years, there is an increasing interest in studying air pollution and exposure using sensor technique in China. For example, high time- and spatial-resolution observation network using sensors has been installed in Beijing by the Beijing Environmental Monitoring Center and other 120 cities in China by Sailhero Environmental Technology, Inc. for long term monitoring purpose. The current observation network first serves its basic purpose, which helps to quickly identify hotspots and point sources of pollutants. Its application in exposure studies and source apportionment of pollutants has received increased attention in different communities. Sensor data have been applied for various purposes by different groups. For example, Shi et al. (2018) use data from the sensor network to determine representativeness of the ground station. The study shows that the representative area for a single station in the study period ranges from 0.25 to 16.25 km<sup>2</sup> but is less than 3 km<sup>2</sup> for most stations. Another study by Si et al. installs sensor in about 100 taxi in a city, and the system can uploads data of particulate matter and GPS location every three seconds, which can real-time map traffic-related pollution in a city. This study summarizes the major ongoing sensor-related programs in China in the following aspects: 1) comparing performance among sensors, 2) evaluating performance under different conditions such as relative humidity and temperature, 3) investigating sources and transport of pollutants, 4) examining spatial variation of pollutants, and 5) estimating exposure levels.

## 003.03A. Advances in Ambient Air Pollution Modeling 2

### 003.03.01. Land-Use Regression Models of Particulate Matter in Temuco, Chile Due to Residential Wood Burning

Carola Blazquez

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**Abstract:** The spatial model development of particle distribution are necessary for studying the chronic health impacts of particulate air pollution due to residential wood- burning. The spatial variability of fine particulate (PM<sub>2.5</sub>) and ultrafine particles (UFP) due to wood-burning has not been studied in Chile. In this study, we used data from a mobile sampling campaign to develop a Land-Use Regression (LUR) model in the city of Temuco, Chile, which is a city heavily impacted by wood-burning. This campaign was performed for 28 days in the winter of 2016, in which PM<sub>2.5</sub> and UFP measurements of 1 s-intervals were recorded along four routes during nighttime when wood burning emissions are the highest. LUR models were developed to yield a map with spatial variability of PM<sub>2.5</sub> and UFP. Predictor variables were obtained from land use, transportation, demography, meteorology, and geography information in a GIS environment. A background normalization of PM<sub>2.5</sub> and UFP mean values at a 100 m resolution was applied to minimize day-to-day urban air quality variations. The results show that the LUR models were capable of explaining 0.43 and 0.31 of the variation in PM<sub>2.5</sub> and PUF, respectively. The number of households, length of local roads, and residential areas were positively correlated with PM<sub>2.5</sub> concentrations, whereas the average density of woodstoves, proximity to local roads, elevation, temperature, and precipitation were negatively correlated with PM<sub>2.5</sub>. The significant predictor variables positively associated with UFP concentrations were total population, major roads length, traffic intensity, and temperature, while the proximity to major roads and precipitation were negatively correlated with UFP. These results provide some insights for the development of a more sophisticated sampling campaign and LUR to be used to study chronic effects of particle exposure.

### **O03.03.02. Applying a Kinetic Multi-Layer Model of Surface and Bulk Chemistry in Epithelial Lung Lining Fluid to Estimate Spatial Variations in the Production of Reactive Oxygen Species in Response to PM2.5 Iron and Copper**

Scott Weichenthal

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**Abstract:** Background: Certain metals may play an important role in the adverse health effects of fine particulate air pollution (PM2.5) but few models are available to predict spatial variations in these pollutants. Methods: We conducted large-scale air monitoring campaigns during summer 2016 and winter 2017 in Toronto, Canada to characterize spatial variations in iron (Fe) and copper (Cu) concentrations in PM2.5. Information on Fe and Cu concentrations at each site were paired with a kinetic multi-layer model of surface and bulk chemistry in the lung epithelial lining fluid to estimate the possible impact of these metals on the production of reactive oxygen species (ROS) in exposed populations. Land use data around each monitoring site were used to develop predictive models for Fe, Cu, and their estimated combined impact on ROS generation. Results: Spatial variations in Fe, Cu, and ROS greatly exceeded that of PM2.5 mass concentrations. In addition, Fe, Cu, and estimated ROS concentrations were 15, 18, and 9 times higher during summer compared to winter with little difference observed for PM2.5. In leave-one out cross validation procedures final multivariable models explained the majority of spatial variations in annual mean Fe ( $R^2= 0.68$ ), Cu ( $R^2=0.79$ ), and ROS ( $R^2= 0.65$ ). Conclusions: The combined use of PM2.5 metals data with a kinetic multi-layer model of surface and bulk chemistry in the human lung epithelial lining fluid may offer a novel means of estimating PM2.5 health impacts beyond simple mass concentrations.

### **003.03.03. Using Measurements of Nitrogen Oxides from a Fixed Sited and a Mobile Platform to Develop Spatially- and Temporally-Resolved Land Use Regression Models**

Laura Corlin

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**Abstract:** Background: Land use regression models can have limited temporal representativeness or spatial resolution if mobile monitoring or fixed site data are used exclusively. Our objective was to build hourly spatial and temporal nitrogen oxides (NO<sub>x</sub>) models for 2003-2015 in Boston and Chelsea (MA, USA) by combining measurements from a mobile platform and a fixed reference site. Methods: NO<sub>x</sub> measurements were made with a chemiluminescence analyzer mounted in a mobile platform. Monitoring sessions (3-6 hours long) occurred on 49 days in Boston and 46 days in Chelsea between 2011 and 2015. Sessions occurred on all days of the week and in all seasons. We obtained hourly NO<sub>x</sub> measurements from a federal monitoring site in Boston. We calculated spatial factors, defined as the location-specific ratio between each 10-second mobile NO<sub>x</sub> value and the corresponding hourly mean fixed site NO<sub>x</sub> value. To model the spatial factors, we tested 43 covariates including transportation network and land use variables with data obtained from public sources. We prioritized covariates that most increased the adjusted-R<sup>2</sup> and made physical sense. We multiplied the modeled spatial factors by the fixed site hourly mean to estimate NO<sub>x</sub> at <200-m and 1-h resolution. Results: The models were stable with two cross validation methods. The most important predictors were distance from major roads, open space, and residential areas; presence of bus/train stops; and an interaction term for wind speed and being downwind of an airport. The models over-predicted at three validation sites, especially when concentrations were low and in places farther from major roads; however, the adjusted-R<sup>2</sup> values for hourly predictions were high (0.53-0.62) and the model captured seasonal and diurnal trends well for both study areas for 2003-2015. Conclusion: Our modeling approach is an efficient way to develop spatially and temporally resolved exposure estimates for use in concurrent and retrospective epidemiology studies.

### **003.03.04. Enhanced Geospatial Modelling of Traffic Related Air Pollution by Deconvoluting on Different Spatial Scales**

Greg Evans

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Abstract: Vehicle emissions represent a major source of air pollution in many urban regions. Local and city-wide traffic, along with regional sources, can influence concentrations. Real-time pollutant measurement using mobile platforms allows assessment of concentrations across large cities but the temporally and spatially varying data thereby obtained can be difficult to interpret. Deconvolution of temporal signals may be an effective way to mine these data so as to isolate the contributions of sources with differing spatial scales. Mobile measurements were collected in Toronto, Canada and three cities in the Netherlands. The data were deconvoluted to isolate the contributions from local, neighbourhood and regional sources using a spline of minimums approach. A range of averaging times (10s to 3000s) was explored to represent these three spatial scales, with longer averaging times representing greater distances travelled by the mobile platforms. The three time-resolved signals, representing different spatial scales, were used to develop land-use regression models. Applying temporal signal deconvolution was found to enhance geospatial-based modeling of exposure in both countries by a small but significant amount. Compared to a conventional model, the deconvolution method increased predictive performance by 12% and 5% for ultrafine particles in Canada and the Netherlands respectively while for black carbon in Canada it only improved modelling by 1%. Further, in both countries the traffic related parameters identified for inclusion in the local scale geospatial models had smaller buffers sizes, while larger geospatial scale and meteorological parameters appeared in the models describing neighbourhood and regional scale contributions. The enhanced geospatial modelling observed for two very different locations indicates that temporal deconvolution is a promising way to interpret the complex temporally and spatially varying data obtained through mobile sampling.

### **O03.03.05. Incorporating Snow and Cloud Fractions in Random Forest to Estimate High Resolution PM2.5 Exposures in New York State**

Jianzhao Bi

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Abstract: Satellite aerosol optical depth (AOD) has been widely used to estimate the ground-level PM2.5 concentrations, but cloud/snow covers often lead to a large proportion of non-random missing AOD, causing difficulties in generating fully covered and unbiased PM2.5. Among the current approaches to address the data gap issue, few have considered the cloud-AOD relationship and none of them considered the snow-AOD relationship. This study aims to examine the influence of satellite-retrieved snow cover on AOD and PM2.5, and to generate accurate PM2.5 predictions in the areas with extensive snow cover. We chose New York State as our study domain since AOD missing rate here was ~ 90% and a large part of them was due to snow cover in winter. To estimate the missing AOD, a gap-filling model with cloud/snow fractions and other meteorological covariates was developed based on random forest algorithm. By applying this model, daily AOD dataset with 1 km resolution in 2015 was generated with complete spatial coverage. The "out-of-bag" R2 of the model averaged 0.93 with an interquartile range from 0.90 to 0.95. A random forest-based PM2.5 prediction model incorporating gap-filled AOD, land use, and meteorological terms was then developed to predict 1 km ground-level PM2.5 in 2015. Ten-fold cross-validation revealed good model performance with an R2 of 0.82. In the gap-filling model, snow fraction had a significantly higher importance in snow season of 2015. Models fitted with/without snow fraction also showed discernable PM2.5 pattern changes, further confirming the importance of this parameter. Compared to methods without explicitly considering cloud and snow cover, our PM2.5 prediction surfaces displayed more spatial details and reflected small-scale terrain-driven PM2.5 patterns. Our method can be generalized to the areas with extensive snow cover for producing reliable PM2.5 predictions with high resolution and complete coverage.

### **O03.03.06. Artificial Neural Networks to Mix Datasets from Particulate Matters and O3 in Medellín, Colombia**

Juan Piñeros Jiménez

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**Abstract:** Mixing the datasets from different air quality monitoring stations to obtain an only dataset that represents a specific air contaminant concentration times series has been considered a difficult task not suited for linear models. The air contaminants datasets mixing is a relevant topic because helps to the data analysts like epidemiologist to obtain a time series from a location (city, town, neighbor) and relate it to another event or phenomena (morbidity and mortality events). In this work, we proposed the basic Artificial Neural Network (ANN) architecture has a merging method and we use it to obtain the daily average concentration for Particulate Matters (PM10, PM2.5), and O3 air contaminants from ten data sets to Medellín (Colombia) between 2008 and 2016. The ANN is a connectionist system inspired by the biological neural network, its goal is to learn the nonlinearities from the data and it is tolerant to modeling datasets with noise, outliers, and missing values. However, like other traditional techniques, the ANN can suffer overfitting. To control it, we used the weight decay strategy as regularization method and backpropagation with cross-validation as the learning algorithm. The algorithms were implemented in R programming language. We compared the air contaminants ANN mixed with the traditional mixing methods (the mean and median of the data sets). The merging performance of the ANN was better than the traditional method. In conclusion, the ANN merging can capture the dynamics and variability of the air contaminants datasets better than the traditional method. In addition, ANN are a suitable method to mix data values from a different air quality monitoring stations.

## 003.03B. Advancing Exposure Methodology through Suspect Screening and Non-Target Analysis

### 003.03.07. Suspect Screening Analysis to Identify Chemical Targets in Serum for Exposure Reconstruction

Barbara Wetmore

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Abstract: Analysis of commercial chemicals in human biomonitoring efforts has been limited largely to those that are bioaccumulative with known or likely human health impacts. Exposure reconstruction using high throughput and other exposure models currently rely on these data alone for evaluation. The evolution of high resolution mass spectrometry affords the opportunity to expand the number of commercial chemicals for which such data are available. Suspect screening analysis (SSA) using two-dimensional gas chromatography-time of flight/mass spectrometry (GCxGC-TOF/MS) was performed on serum samples obtained from the National Institute of Environmental Health Sciences Clinical Research Unit. Samples were stratified based on sex (male vs. female). Tentative chemical identifications (IDs) were only assumed if a compound peak was identified in two of the three replicates, and if the spectrum for that peak had a high similarity to a spectrum in the NIST14 mass spectral library. Five hundred forty-six unique compounds were tentatively identified and assessed; 240 were detected in males, while double (480) were found in females. Two hundred seven compounds were unique to females while only 28 were unique to male serum. Sixty-nine of the tentatively identified chemicals were also detected in a pilot SSA that characterized chemical presence in consumer products (CP); 204 are present in US EPA's CPDat database, containing product composition and functional use data; and 5 are among the chemicals monitored in the National Health and Nutrition Examination Survey (NHANES) (e.g., naphthalene, cotinine, and 2,5-dichlorophenol). Ongoing work is focused on further identification efforts and strategies to facilitate semi-quantitative assessments. These preliminary findings provide support for the use of SSA in expanding the biomonitored chemical space for exposure reconstruction and model evaluation to inform chemical safety assessments. This abstract may not reflect U.S. EPA policy.

### **O03.03.08. Environmental Exposure Induced Metabolic Profiling Alterations in a Migration Panel between Los Angeles and Beijing**

Xinghua Qiu

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**Abstract:** Migration provides individuals experiencing different environmental exposure episodes naturally, which offers a chance to attribute physiological response to certain exposure factors. To reveal the mechanism of health effect under environmental exposure, we designed a migration panel study between Los Angeles and Beijing, two cities with different exposure levels. Specifically, serum samples were collected from 27 summer school exchange students three times in total, one week before their departure (LA1), and at least four weeks respectively after their arrival to Beijing (BJ) and return to Los Angeles (LA2). The metabolic profiling was obtained through untargeted metabolomics approach with a high resolution TOF-MS. Combining with a series of statistical methods like Mann-Whitney test and Orthogonal partial least squares discriminant analysis, we screened prospective markers that changed significantly between LA and BJ. The significant decrease ( $p < 0.001$ ,  $FC > 1.2$ ) of indole and its precursor tryptophan in BJ reflected the induction of AhR and CYP by higher levels of pollutants. The decreased cortisol ( $p < 0.001$ ,  $FC > 1.5$ ) was potentially due to the accelerated consumption of CYP3A, supplying further evidence of enhanced CYP activity and related xenobiotics elimination in BJ. On the other hand, the increase of IL-8 and IL-10 from cytokine analysis suggested the oxidative stress during the process. A slightly higher level of uric acid ( $p < 0.01$ ,  $FC > 1.1$ ) along with its precursors implied the upregulation of antioxidation under the environmental exposure in BJ. Generally, this study illustrated that metabolomics offered an effective tool to assess the overall health impact under subchronic exposure.

### **O03.03.09. New Insights of Human Exposure to Consumer Product Chemicals from Comprehensive Chemical Profiles of Indoor Dust**

Hyeong-Moo Shin

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**Abstract:** Background: For semivolatile organic compounds (SVOCs) with low vapor pressure, the levels in indoor dust are known to serve as an alternate marker of chemical exposure with common indoor sources. However, a complete picture of chemical fingerprint (i.e., identity and quantity of all chemicals present in dust) is missing because most previous studies focused on the analysis of known chemical classes in dust samples via a targeted analytical approach. Objective: This study presents concentrations of a broad spectrum of SVOCs in household dust measured via a comprehensive analytical workflow. Methods: We quantified SVOCs in dust samples collected from 38 California homes by applying a combination of target, suspect, and non-target screening approaches to liquid chromatography quadrupole time-of-flight mass spectrometry (LC-QTOF/MS) and gas chromatography (GC)-QTOF/MS. We used authentic standards to detect known compounds (targets), used existing databases or libraries, or software matching algorithms to detect expected compounds (suspects), and carefully examined the high-resolution mass spectra to identify previously unknown compounds (non-targets). Results: A total of 257 compounds were detected in at least one sample and 170 compounds were detected in more than 50% of the samples. Of the 257 compounds, 168 compounds were unambiguously confirmed and quantified by reference standards and 135 compounds were detected for the first time in U.S. household dust. Median concentrations ranged from 5 to ~100,000 ng/g of dust. We confirmed that 17 and 7 compounds newly detected in our dust are known to have endocrine disrupting and neurotoxic potential, respectively. Conclusions: We expect that a comprehensive investigation of chemicals present in dust from the present study will expand our knowledge of chemicals in household dust and will be the basis for further investigations in finding chemicals potentially associated with adverse health effects.

### **O03.03.10. Towards the Development of a Framework for Applying Non-Target Chemical Analysis Data within Exposure and Risk Assessment**

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Abstract: There is an increasing trend towards multi-targeted and non-target analysis (NTA) screening methods to increase the number of analytes monitored in biomonitoring and environmental samples. While the opportunities from advances in chemical analytical capabilities have shown substantive development over recent years, application of information related to data reported from non-target analysis represents a challenge to the field of exposure modelling. For instance, there is no framework for interpreting and using data reported from studies involving non-target analysis to inform exposure and risk. The absence of guidance may consequently lead to difficulties in prioritizing risk assessment activities. In this study we examine the state of the science with respect to non-target analysis, and present a summary of the merits and limitations for exposure assessment and risk assessment. These preliminary observations are then used to propose an initial framework for the appropriate use of non-target analysis data within exposure assessment. The recommendations concludes with a number of suggestions regarding how these data can be better gathered and reported in order to strengthen their applications for chemical risk assessment, including emerging contaminants.

### **003.03.11. The Pregnancy Chemisome in Relation to Birth Outcomes and Consumer Product Use: Suspect Screening of Industrial Chemicals**

Aolin Wang

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**Abstract:** Our study aims to characterize the chemical exposome among a diverse cohort of pregnant women and examine their relationship with birth outcomes, demographics, and consumer product use. We used liquid chromatography-quadrupole time-of-flight mass spectrometry to perform a suspect screen for 349 endocrine disrupting chemicals and 3000+ high-use industrial chemicals (based on Chemical Data Reporting 2016) in serum collected at delivery from 200 pregnant women in Northern California, and obtained both detection frequency and peak areas (relative concentration) for each suspect (matched by mass) compound. Analytical methods included multivariable linear/logistic regression, and an unsupervised machine learning technique association rule mining (ARM). We detected, on average, 60 suspects (SD=17, range: 21-100), the majority of which were matched to suspect environmental phenols or phthalate metabolites. Women with post-term (v.s. full term) babies have a lower number of suspects whereas those with low birth weight (LBW) babies have a higher number of suspects (b= -9 and 11 respectively). No demographic differences were observed in the number of suspects except that women with lower education appeared to have more suspect phthalate metabolites but small peak areas of suspect perfluorooctanesulfonic acid (PFOS). Peak areas of highly detected suspects were generally negatively associated with pre- and post-term birth and LBW, but positively associated with daily use of shampoo/conditioner and lotion (all FDR-adjusted  $p < 0.1$ ). ARM analysis suggested that lip balm, lotion, and deodorant are often used daily, and their use is associated with a higher number of suspects (support  $> 0.15$ , confidence  $> 0.8$ , and lift  $> 1$ ). Our results suggest associations of suspect chemicals in maternal serum with birth outcomes and consumer product use. Techniques such as the ARM could provide data-driven insights into potential patterns of chemical exposures and maternal characteristics.

### **O03.03.12. Ethical Dimensions of Advancing Exposure Methodology through Suspect Screening and Non-Target Analysis**

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Abstract: Given knowledge about the likelihood of harmful effects resulting from continued exposure, biomarkers of exposure provide evidence of exposure and thus assist in targeting Primary Prevention messaging in public health. Secondary Prevention involves screening to identify people who, given exposure, are experiencing patho-physiological changes that risk morbidity and premature mortality. The goal in Secondary Prevention is "early detection" as a means to interventions that could halt pathogenesis, preventing clinical manifestations and premature mortality. The focus in both Primary and Secondary Prevention in public health is on people, rather than on the more precise assessment of exposure. The latter, however, informs the former. On the exposure assessment side, the ability to develop tools to identify people who are likely unaware that they are exposed through the detection of biomarkers of exposure could add to prevention and teaching tools useful to advancing the public's health. Advances in technology make it possible for refined measurement tools for screening populations in ways unachievable in the past. What are the consequences of screening, both good and bad? The meta-ethical question is: Do we let technology drive our future, or can we shape it through ethical considerations? Simply put: Do we do what we do because we can or because we should? Practically, should we address exposure assessment without also considering health outcomes? Is it ethical not to translate results from health research into policy? Despite questions, the trajectory that humankind is on is one driven by technological advance. Ethical dimensions are often left to be considered after the fact, once the stable door has been opened. Being aware of this can enhance our role as citizen scientists. The ethical implications of exposure assessment tools will be drawn upon to engage delegates in discussion.

## O03.03C. Air Pollution, Obesity, and Metabolic Disease

### **O03.03.13. Particulate Air Pollution Exposure during Pregnancy and Mitochondrial-Associated Plasma Metabolites in Mothers at 48 Months Postpartum: A Pilot Study**

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**Abstract:** Background Pregnancy and early postpartum life are periods of major metabolic change in women and may be critical windows of susceptibility for longer-term metabolic changes induced by inflammatory exposures, such as PM<sub>2.5</sub> (ambient particulate matter <2.5 μm in diameter). Hypothesis As mitochondria are sensitive to inflammation, we hypothesized that gestational/early postpartum PM<sub>2.5</sub> exposure would predict metabolomic profiles of small molecules in mitochondrial-associated pathways measured years after pregnancy. Methods In a pilot study, we randomly selected 50 mothers from the Programming Research on Obesity, Growth, Environment and Social Stress (PROGRESS) cohort based in Mexico City. We estimated PM<sub>2.5</sub> exposure using a satellite-based spatiotemporally-resolved prediction model. In maternal plasma collected at 48 months postpartum, we assessed 110 metabolites in mitochondrial pathways (TCA cycle, fatty acid β-oxidation, and branched chain amino acid catabolism) using Metabolon's Discovery HD4T platform. Results In robust regression models adjusted for age, secondhand smoke exposure, socioeconomic status, alcohol consumption, and parity, average PM<sub>2.5</sub> during the first year postpartum was associated with 17 metabolites (p<0.05). The majority were long chain fatty acids and polyunsaturated fatty acids, which were negatively associated with PM<sub>2.5</sub>. No associations were observed for these fatty acids with average PM<sub>2.5</sub> during pregnancy. Further, fewer metabolites overall were associated with PM<sub>2.5</sub> during pregnancy (two at p<0.05), suggesting results vary by time of exposure. Conclusion In this pilot study, we found that PM<sub>2.5</sub> exposure during the first year postpartum was associated with altered fatty acid metabolism in plasma from mothers at 48 months postpartum. The postpartum period may be a susceptibility window for PM<sub>2.5</sub> exposure with regard to metabolic dysregulation, particularly lipids. We plan to replicate these findings in the full sample and in independent cohorts.

### **003.03.14. A Pathway to Diabetes? Associations between Air Pollution Exposure and Biomarkers of Inflammation and Metabolism in Nondiabetic Persons.**

Sarah Lucht

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**Abstract:** Background: While prior studies have linked air pollution (AP) and diabetes, few studies have examined potential intermediate steps, such as inflammation and altered glucose metabolism, in metabolically healthy persons. Objective: To characterize associations between AP and biomarkers of inflammation and metabolism in nondiabetics. Methods: Biomarker measures (high-sensitivity C-reactive protein [hs-CRP], adiponectin, fibrinogen, interleukin-1 receptor antagonist [IL1-RA]) were collected at baseline (t<sub>0</sub>; 2000-2003) and first follow-up (t<sub>1</sub>; 2006-2008) exams from nondiabetic participants of the Heinz Nixdorf Recall (HNR) study. Residential mean exposure to PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, and accumulation mode particle number concentration (PNAM) was calculated for time windows (1- to 365-day) prior to exam using a dispersion and chemistry transport model. We fitted covariate-adjusted linear mixed effects models and ran two-pollutant models for PNAM and NO<sub>2</sub>. Results: We analyzed 6,727 observations (n<sub>t0</sub>=3,626, n<sub>t1</sub>=3,101) from 4,052 participants of the HNR study (52% women; age 45-76 years at t<sub>0</sub>). Interquartile range (IQR) increases in 365-day mean exposure to PM<sub>10</sub>, PM<sub>2.5</sub>, and PNAM were associated with higher hs-CRP levels (e.g., PM<sub>2.5</sub>: 6.6% [95% CI: 2.8, 10.7] per IQR increase). Short-term exposure to all pollutants was positively associated with IL1-RA (e.g., 1-day PM<sub>10</sub>: 1.5% [0.6, 2.5] per IQR increase), with associations also seen for medium- and long-term exposures. Medium-term exposures (60- to 120-day) were negatively associated with adiponectin (e.g., 91-day PNAM: -2.2% [-3.3, -1.3] per IQR increase). No clear pattern was seen for fibrinogen. Associations for PNAM and NO<sub>2</sub> were robust to co-pollutant adjustment. Conclusion: In nondiabetics, we observed differing temporal patterns of association between AP and biomarkers of inflammation and metabolism, indicating that several exposure windows may be relevant for evaluating potential mediators of the link between AP and diabetes.

### **003.03.15. Ozone Exposure, Glucose Homeostasis and Insulin Resistance in the U.S.A.**

Xiaohui Xu

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**Abstract:** Ozone Exposure, Glucose Homeostasis and Insulin Resistance in the USA Background: Epidemiological studies have suggested the associations between ambient air pollution levels and metabolic syndrome as well as diabetes. However, studies based on a national-wide sample are limited. Materials and Methods: In this study, we used the 1999-2002 restricted-access National Health and Nutrition Survey data (n=4,341 adults) to investigate the effects of air pollutants including fine particles (PM<sub>2.5</sub>) and ozone (O<sub>3</sub>) on glucose homeostasis and insulin resistance. We calculated daily average levels of air pollutants on each day in the preceding week and the preceding 1-month, 3-month, and annual averages of air pollutants at participants' geocoded home address. Linear regression models were applied for fast glucose, insulin, hemoglobin A1c (HbA1c), homeostasis model assessment of  $\beta$  cell function (HOMA- $\beta$ ), and insulin resistance (HOMA-IR). Logarithm transformation was applied to skewed variables. Results: We found that exposure to O<sub>3</sub> was significantly positively associated with fasting glucose level at lag days ( $\beta=1.18-1.69$  per 1 ppm change in O<sub>3</sub>,  $P < 0.05$ ), one month ( $\beta=1.97$ ,  $P = 0.02$ ), three months ( $\beta=2.29$ ,  $P = 0.03$ ) and one year window of exposure ( $\beta=3.47$ ,  $P = 0.01$ ). Additionally, O<sub>3</sub> exposure was significantly negatively associated with and HOMA- $\beta$  for all lag times. Monthly, 3-month and annual averages of O<sub>3</sub> were also positively associated with HbA1c. However, PM<sub>2.5</sub> was shown to have no strong relationship with these outcome measurements. Conclusions: Our study suggested that exposure to O<sub>3</sub> may have adverse effects on glucose homeostasis and  $\beta$ -cell function. The findings warrant further investigation.

### **003.03.16. Exposure to PM2.5 in Mexico City's Metropolitan Area and Its Association with Obesity**

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**Abstract:** In Mexico City's Metropolitan Area (MCMA), home to over twenty million persons, air quality usually surpasses the standards for PM 2.5, and obesity is highly prevalent. Recent studies suggest inflammation as a possible link between PM 2.5 exposure and this disease, however epidemiologic research on this subject is scarce and has not been studied in a representative sample of the MCMA. We used data from the 2006 and 2012 Mexican Surveys of Health and Nutrition that have a multistage probabilistic sampling design, to estimate the association between PM 2.5 exposure and obesity in a representative sample of adults, adolescents 10-18 years old and children 2-9 years old from the MCMA. The yearly average PM 2.5 exposure was calculated for each participant's block address using satellite data, calibrated with the air quality network of ground air monitors. We used the sampling weights and clusters of the survey to estimate logistic regression models that were adjusted for age, sex, SES and tobacco (except in children); estimation was done with STATA svy program. Prevalence (% (95% C.I) of obesity was 29.9% (27.7-32.3) in 2006 and of 31.5% (28.5-34.6) in 2012 for adults; of 16.6% (13.5-20.3) in 2006 and of 15.9% (13.5-18.4) in 2012 for adolescents, and of 21.3% (17.7-25.5) in 2006 and of 18.8% (16.4-21.5) in 2012 for children. An increase of 10 µg/m<sup>3</sup> in the annual exposure to PM 2.5 was associated with obesity in adults for 2012, OR=2.73 (p=0.05, 95% C.I. 0.96-7.70) and in adolescents, for 2006 OR=3.40 (0.008; 1.39-8.26) and for 2012, OR=3.79 (0.01; 1.40-10.23). Results were inconclusive for children. Although obesity is a multifactorial disease, PM 2.5 might be an environmental risk factor contributing to this world-wide epidemic.

### **O03.03.17. The Impact of Indoor Fine Particles on Body Mass Index, Waist Circumference, and Triglyceride of Korean Housewives Cohort Study: Preliminary Results**

Shinhee Ye

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**Abstract:** Background: Few studies have evaluated the associations between indoor particulate matter (PM) and cardiovascular disease (CVD) risk factors in housewives who are exposed to large amount of indoor PM as they spend great deal of time doing house chores such as cooking and cleaning. Hence, we investigated the association between indoor PM and the CVD risk factors in housewives. Methods: We recruited 25 housewives (January to March 2018) in Ulsan, an industrial city, Republic of Korea. We measured indoor PM<sub>2.5</sub> (particulate matter <2.5 in diameter) concentrations at participant's house using weight method for 24hrs. Thereafter, participants were invited to hospital for a physical examination and collecting bio specimens (blood and urine) to analyze inflammatory markers, lipid profile, fasting insulin, and fasting glucose. Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), body mass index (BMI), and metabolic syndrome (MS) were further defined. The association between PM<sub>2.5</sub> and CVD risk factors were evaluated using multiple linear regression or multiple logistic regression analysis. Results: The average indoor PM<sub>2.5</sub> concentration was 42.7 µg/m<sup>3</sup> (range: 13.2-143.2 g/m<sup>3</sup>). BMI (beta=0.06; 95% confidence interval (CI)=0.00-0.11), waist circumference (beta=0.15; CI=0.03-0.27), and triglyceride (beta=1.26; CI=0.19-2.33) were significantly associated with 1 g/m<sup>3</sup> increase of indoor PM<sub>2.5</sub>. The association between MS and PM<sub>2.5</sub> was marginally significant (odds ratio=1.09; CI=1.00-1.20). Blood pressure, C-reactive protein, total cholesterol, low density lipid cholesterol, fasting insulin, and HOMA-IR were increased with PM<sub>2.5</sub> concentrations, but not significant. Conclusions: In this preliminary study, several CVD risk factors are likely to be associated with an indoor PM<sub>2.5</sub> exposure in housewives. This study will be extended by recruiting about 300 housewives by 2019 to clarify this association.

### **O03.03.18. Methylation Marks to Inform Association between Early-Life Air Pollution Exposures and Child Body Mass Index: An Analysis Based on A Priori Selected Pathways**

Solène Cadiou

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**Abstract:** Background: Early-life exposure to air pollution has been suggested to influence childhood growth and Body Mass Index (BMI). DNA methylation changes might explain part of this effect. Yet, methylome-wide studies with population sizes under 1000 generally suffer from lack of power. Using a priori information to reduce data dimension is an option to face this challenge. Aim: To identify genes whose methylation level is possibly implied in air pollution effect on child BMI, with a 'Meet in the middle' approach, using a priori information from functional pathways. Methods: Among 1173 mother-infant pairs from Helix cohorts, exposures to 4 outdoor air pollutants were assessed during pregnancy and at age 7-9 years (total 16 exposures). Genome-wide DNA methylation levels in peripheral blood at 7-9 years was measured using HumanMethylation450 BeadChip, with quality control, batch and cell types adjustments. We a priori considered only 2276 CpGs from genes belonging to 16 growth or obesity-relevant pathways according to KEGG pathway database. Stabilized Elasticnet regression (ENet) was used to independently assess associations of DNA methylation with exposures and BMI. We identified exposures sharing associated CpG sites with BMI and assessed their direct association with BMI using ENet. Results: Exposures were associated with 358 CpG loci; 12 exposures were associated with CpGs also associated with BMI (total, 22 CpGs). One of these exposures, PM10 level the day before blood collection, was associated with BMI. This exposure was associated with 62 CpGs, 2 of which being also associated with BMI, on PIK3CA (thyroid hormone signaling pathway) and ELOVL3 genes (fatty acid elongation pathway). Conclusion: Our hypothesis-generating approach identified 358 CpGs from BMI-relevant pathways associated with air pollutants, including 22 related to child BMI. These CpGs provide hints as to which genes may be implied in mechanisms underlying air pollution effects on child growth.

## 003.03D. Cancer Epidemiology

### **003.03.19. Non-Hodgkin Lymphoma Associated with Organophosphate and Carbamate Insecticides in the North American Pooled Project**

Laura Beane Freeman

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Abstract: Historically, organophosphate and carbamate insecticides have been among the most commonly used insecticides, with both agricultural and residential uses. Previous studies have suggested associations with some of these chemicals and non-Hodgkin lymphoma (NHL); however, many have been limited in their ability to evaluate associations with subtypes. We evaluated the use of eleven organophosphate and two carbamate insecticides in association with NHL in the North American Pooled Project, which includes data from case-control studies in the United States and Canada (1,690 cases/5,131 controls). We used unconditional logistic regression adjusting for potential confounders, including use of other insecticides, to estimate odds ratios (OR) and 95% confidence intervals (95% CI) for associations between these chemicals and NHL overall, and follicular (FL), diffuse large B-cell (DLBCL), small lymphocytic lymphoma (SLL) and other subtypes. Ever use of the insecticide malathion was associated with increased risk of NHL overall in 172 exposed cases (OR=1.43; 95% CI: 1.14-1.81) compared to never users. The risk was highest in those who reported using malathion >6 years (n=103 cases) (OR=1.57; 95% CI: 1.18-2.10). In addition, there were statistically significant associations for FL (OR=1.58; 95% CI: 1.11-2.27) and DLBCL (OR=1.61; 95% CI: 1.16-2.22) subtypes. There were no apparent associations with SLL or other subtypes. The carbamate insecticide carbaryl was associated with a non-significantly increased risk of NHL overall for ever use (OR=1.17; 95% CI: 0.84-1.64) among 75 exposed cases, and for >6 years of use (OR=1.24; 95% CI: 0.78-1.99). There was a statistically significant increased risk of SLL, but not other subtypes, with ever use of this chemical (OR=2.12; 95% CI: 1.01-4.42). These results support previous studies suggesting an association between these commonly used insecticides and NHL overall, and provide new information on associations with NHL subtypes.

### **003.03.20. Heterogeneity of the Arsenic-Bladder Cancer Relationship by Tumor p16/Rb Immunophenotype**

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**Abstract:** Several studies have suggested arsenic may target important tumor-suppressor genes and disrupt cell cycle control and influence bladder cancer risk. In a large, population-based case-control study we evaluated whether there was heterogeneity in the arsenic-bladder cancer risk relationship by tumor expression of p16 and Rb. Tumor tissue from bladder cancer cases was assembled as tissue microarrays and examined for expression. Cutoff values used to define negative/positive staining were based on the distribution of the percentage of positive cells in cases. Data on cumulative arsenic from drinking water were used to evaluate the relationship between arsenic and bladder cancer by immunophenotype (p16-/p16+, Rb-/Rb+), in 424 cases and 1287 controls, using polytomous logistic regression. Our results show that the association between increasing cumulative arsenic and bladder cancer risk was only apparent among patients with p16+ or Rb+ tumors. We observed a strong monotonic association between risk and increasing cumulative arsenic intake (Quartile2-4 vs. Quartile1, OR<sub>p16+</sub> =1.36, 1.47, 1.85, p-trend=0.004 and OR<sub>Rb+</sub> =1.51, 1.56, 1.94, p-trend=0.007). No association between cumulative arsenic and risk among patients with p16- or Rb- bladder tumors was apparent (p-heterogeneity by subtype=0.0325 for p16 and 0.0551 for Rb). This heterogeneity was not evident by stage or grade. Our data suggest a low frequency of homozygous deletion of CDKN2A (the gene that encodes p16), as well as inactivating mutations of RB1 in arsenic-induced bladder cancer, pointing to an alternate mechanism. Increased p16 expression may be indicative of hypermethylation of CDKN2A, an intensively studied mechanisms for arsenic-induced carcinogenesis. Our data provide additional evidence linking arsenic exposure and bladder cancer risk and point to alterations of the cell cycle as the relevant pathway, although the precise mechanisms need further evaluation in additional experimental and human studies.

### **O03.03.21. Untargeted Metabolomics of Archived Dried Blood Spots Reveals Lipid Modulation at Birth Associated with Pediatric Acute Lymphoblastic Leukemia**

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Abstract: Acute lymphoblastic leukemia (ALL) is the most common form of childhood leukemia. Metabolomics analysis of archived dried blood spots (DBS) collected at birth provides a snapshot of early life exposures that can provide insights into the causes and underlying prenatal biology of ALL. We received single 4.7-mm DBS punches (equivalent to ~8  $\mu$ L whole blood) collected between 1985 and 2005 for over 300 ALL cases and their matched controls as part of the California Childhood Leukemia Study. Matching was performed on date of birth and gender and roughly matched on ethnicity. DBS were extracted with acetonitrile and analyzed with an Agilent 1290 UHPLC system connected to a 6550 QTOF HRMS (Santa Clara, US) in ESI (-) mode. Analysis was performed on subjects stratified by age at diagnosis as a means of distinguishing between potentially different ALL phenotypes (early: 1-5 years; late: 6-14 years). In order to minimize the number of false positives, associations between metabolite features and ALL were determined with an ensemble of statistical methods, namely, linear regression p-values, bootstrapped regularized logistic regression (LASSO), and random forest. There was no overlap in features selected for associations with early diagnosis (9 features) and late diagnosis (24 features) of ALL. Annotated metabolites were primarily fatty acid and glycerophospholipids. Several of the selected metabolites were associated with the time to ALL diagnosis, suggesting that they reflect effects of disease progression rather than causal exposures. Interestingly, several metabolites selected in the late diagnosis group were highly associated with breastfeeding practice, a known risk factor of ALL. Since DBS are collected within 48 hours of birth, they include nutrients from one or more infant feedings. These results suggest that lipids associated with neonatal nutrition may be involved with initiation of ALL in early life and should be a focus of future targeted research.

### **003.03.22. Hematologic Perturbations among Pesticide Applicators Recently Exposed to Permethrin in the Agricultural Health Study**

Joe Shearer

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**Abstract:** In the Agricultural Health Study (AHS), a large prospective cohort of pesticide applicators, exposure to the pyrethroid insecticide permethrin is associated with an increased risk of multiple myeloma (MM), a hematologic malignancy with an unfavorable prognosis. To gain insight into the biological mechanisms underlying this association, we assessed potential hematotoxic effects of permethrin, in a longitudinal study of 35 permethrin-exposed male pesticide applicators in the AHS. Serial blood samples were collected from each participant in the off-season, the day after permethrin use, and approximately 3 weeks after use. At each time point, we performed a complete blood count with white blood cell differential and measured lymphocyte subsets. We used linear mixed models to assess the relationship between permethrin exposure and cell counts, controlling for season, age, BMI, recent cold/infection ( $\leq 7$  days), and use of other pesticides ( $\leq 30$  days). We observed a statistically significant increase in the geometric mean of immature granulocytes (31%, 95% CI=6%, 63%) on the day after permethrin use relative to off-season levels, but not 3 weeks after use. Statistically significant ( $P < 0.05$ ) alterations in several red blood cell parameters were also observed on the day after permethrin use, including decreased red blood cell count, hemoglobin, and hematocrit and increased mean corpuscular volume and red blood cell distribution width-SD. Red blood cell count, hemoglobin, and hematocrit remained significantly decreased 3 weeks after permethrin use. Increased immature granulocytes are indicative of an inflammatory response and enhanced bone marrow activity, and sustained decreases in red blood cell parameters may be a result of increased oxidative stress. Our results suggest inflammatory and hematologic effects of permethrin exposure, and identify targeted cell populations for future mechanistic studies to elucidate the relationship between permethrin use and MM risk.

### **003.03.23. Sun Avoidance and the Risk of Developing Breast Cancer: A Systematic Review and Meta-Analysis**

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**Abstract:** Background: A relationship has been hypothesized between moderate solar ultraviolet radiation (UVR) exposure and breast cancer. This hypothesis centers on the anti-proliferative and apoptotic properties of vitamin D, as well as increases in nocturnal melatonin concentrations which have been shown to slow cellular proliferation. To date, the literature on the effects of exposure to UVR and breast cancer risk have not been systematically reviewed and synthesized. Furthermore, the effects of sun avoidance (low amounts of time spent in the sun) in different exposure windows (adolescence vs. a period relevant to diagnosis) have not been compared. Methods: We conducted a systematic review and meta-analysis to investigate the association between sun avoidance (defined as less than an hour of sun per day) and the risk of developing breast cancer. Associations were estimated using random effects models. Heterogeneity was investigated through subgroup analyses and I<sup>2</sup> statistics. Results: Seven studies were included in this review with the majority (n=5) being conducted in Canada or the US. We observed an increased risk of breast cancer for individuals obtaining less than an hour of sun exposure per day during summer months compared to individuals that obtained greater than an hour (pooled relative risk (RR) = 1.15; 95% CI: 1.09-1.20). Heterogeneity among this body of literature was minimal (I<sup>2</sup> = 2.7%) Among studies that measured sun exposure over different life periods, sun avoidance during adolescence appeared to confer a qualitatively greater risk of breast cancer than that closer to diagnosis (pooled RR = 1.18; 95% CI: 1.05-1.30 vs. 1.05; 95% CI: 0.88-1.25). Conclusion: This is the first meta-analysis to estimate the risk of developing breast cancer associated with sun avoidance. The results of this study suggest that obtaining less than one hour of sun per day during summer months, especially in adolescence, could increase the risk of developing breast cancer.

### **O03.03.24. Different Coffee Products and Breast Cancer Risk among Hong Kong Chinese Women**

Ming Yi Lee

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**Abstract:** Background: Coffee contains caffeine and polyphenols that were reported to be able to low breast cancer risk, but the evidence from epidemiological studies remains inconsistent. Coffee products (i.e. instant, brewed) contain various levels of sugars and food additives, and thus their effects on breast cancer may vary and research on this area is lacking. This study aims to investigate the associations between coffee products and breast cancer risk among Hong Kong Chinese women. Methods: We conducted a hospital-based case-control study in three public hospitals, 1835 Chinese women (912 controls and 923 incident breast cancer cases) aged 24 to 84 years were consecutively recruited and interviewed using a standardized questionnaire including detailed information on coffee drinking. Results: There were no associations between overall coffee drinking and breast cancer risk. Interestingly, the association between instant coffee and breast cancer risk was contradicting to that of consuming coffee from restaurant. Compare to non-habitual coffee drinkers, women who drank  $\geq 1$  cup(s) of instant coffee per day (adjusted odds ratio (OR)=1.47, 95% confidence interval(CI)=1.02-2.11) was significantly associated with an increased risk of breast cancer after adjusting their age, body mass index, family history of breast cancer, educational level and shift work experiences. On the other hand, women who drank  $\geq 1$  cup(s) of coffee from restaurant/chain coffee per day (adjusted OR=0.34, 95% CI= 0.12-0.94) was negatively associated with breast cancer risk. Conclusion: Coffee products under different processing methods may be a novel risk factor for breast cancer and further research is warranted.

## 003.03E. Chemical Exposures in Vulnerable Populations

### **003.03.25. Influence of Genetic Variance on Occupational Exposure to 1,6-Hexamethylene Diisocyanate (HDI) and Its Trimer HDI Isocyanurate**

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**Abstract:** Polyurethane spray-painting can result in significant occupational exposure to 1,6-hexamethylene diisocyanate (HDI) monomer and its trimer, HDI isocyanurate. Inter-individual genetic differences have been linked with adverse health effects and asthma risk in isocyanate-exposed workers. However, little is known about inter-individual differences in response to HDI isocyanurate exposure compared to the HDI monomer. We are investigating the similarities and differences in exposure-dose responses and the genetic variants that modify or predict relationships between toxicokinetics and biomarker levels in exposed workers. Inhalation and skin exposure to HDI monomer and HDI isocyanurate were measured in 33 spray-painters along with the respective urine and blood biomarkers of 1,6-hexamethylene diamine (HDA) and trisaminohexyl isocyanurate (TAHI). Genome-wide microarrays (Affymetrix 6.0) were used to genotype the workers' single nucleotide polymorphisms (SNPs) and to conduct a genome-wide association study (GWAS). Using exposure values as covariates and a false discovery rate <0.20 for significance, GWAS showed that one SNP was associated with TAHI levels in urine, six SNPs were associated with HDA in plasma, and twelve SNPs were associated with HDA levels in urine. No SNP associations reached significance for TAHI levels in plasma. The SNPs were tested in linear mixed models (LMM) and bioinformatics data of the genes proximal to the top ten most significant SNPs for each compound were assessed for biological plausibility. Bioinformatics for HDI monomer associated SNPs included predicted interactions involving signal transduction and the immune function. Bioinformatics for HDI isocyanurate predicted interactions for cell signaling, structure, and adhesion. We demonstrate that genetic variance impacts the biomarker levels in workers exposed to HDI monomer and HDI isocyanurate, and that HDA and TAHI levels can be used to refine exposure prediction models for both compounds.

### **003.03.26. Association of Heavy Metals with Measures of Pulmonary Function in Youth: Findings from the 2011-2012 National Health and Nutrition Examination Survey (NHANES)**

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**Abstract:** Exposure to cadmium, cobalt, lead, and manganese occurs through inhalation of industrial pollution and tobacco smoke, or ingestion of contaminated food and water. High exposure to these metals has been associated with decreased pulmonary function in adults. Little is known about these associations in children exposed at low levels in the United States (U.S.). We evaluated the cross-sectional associations of blood and urinary concentrations of cadmium, cobalt, lead, and manganese in relation to pulmonary function [forced expiratory volume in one second (FEV1; mL), forced vital capacity (FVC; mL), FEV1 to FVC ratio (FEV1:FVC), and midexhalation forced expiratory flow rate (FEF 25-75%; mL/second) in a sample of 1,234 U.S. children and adolescents aged 6 to 17 years from the 2011-2012 cycle of the National Health and Nutrition Examination Survey (NHANES). Survey-weighted linear regression models were performed to estimate beta coefficients and their 95% confidence intervals (CIs), adjusting for age, race, sex, height, family income, respiratory medication use, exposure to tobacco smoke, and urinary creatinine concentration (urinary exposure models only). Blood manganese concentration was inversely associated with FVC ( $\beta$  for highest versus lowest quartile=-97.1, 95% CI=-230.6, 36.4;  $p$  for trend=0.03). The associations of blood manganese with both FEV1 and FVC differed by age ( $p$  for interaction=0.04 and 0.03, respectively), indicating an inverse trend that was strongest among youth aged 11-17. Urinary manganese was inversely associated with FEV1:FVC and FEF 25-75% ( $p=0.05$  and  $0.02$ , respectively). Urinary lead was inversely associated with FEF 25-75% ( $p=0.01$ ). Our findings suggest that environmental manganese and lead exposure may adversely impact the pulmonary function of children. This association highlights the need to prioritize environmental health protection, evaluate these associations prospectively, and further investigate underlying mechanisms.

### **O03.03.27. A Bayesian Benchmark Dose Analysis for Manganese in Drinking Water and IQ in Children Based on Pooled Data from Two Studies in Canada**

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**Abstract:** Background: Manganese (Mn) is an essential nutrient but can be neurotoxic at high exposure levels. We carried out two cross-sectional studies on the relation between water Mn levels and IQ in children. Although this metal is commonly found in drinking water, few jurisdictions have adopted a health-based guideline to limit its concentration. The Bayesian Benchmark Dose Analysis System (BBMD) can be used to estimate the level of exposure associated with a predefined health risk in a probabilistic framework. Objective: To pool samples from two studies and use BBMD to estimate the water Mn level associated with predefined levels of cognitive impairment in children, i.e. reduction of 1 and 2 IQ points. Methods: Data from two studies were pooled resulting in a sample of 630 children (ages 6-13 years). We sampled each participant's home tap water and measured Mn concentration. The performance IQ (PIQ) score was used as the primary outcome. The BBMD is based on Bayesian statistics featuring Markov Chain Monte Carlo algorithms for model fitting, parameter and quantity of interest estimation. The weight-averaged median estimate and the lower bound of the credible interval (BMDL) of multiple commonly used dose-response models are reported. Results: The concentration of Mn in drinking water associated with a decrease of 1 PIQ point was 120 µg/L (BMDL, 69 µg/L); for a decrease of 2 PIQ points, this concentration was 243 µg/L (BMDL, 140 µg/L). Different associations for water Mn and PIQ were found between sexes, so stratified analyses were also conducted. The Mn concentration associated with a decrease of 1 and 2 PIQ points in boys was 174 and 354 µg/L (BMDL, 68 and 138 µg/L) and 72 and 94 µg/L (BMDL, 9 and 19 µg/L) for girls. Conclusion: A maximum acceptable concentration for manganese in drinking water should be set to protect children, the most vulnerable population for Mn neurotoxicity. The present risk analysis can guide the decision-makers regulating water quality.

### **003.03.28. Effects of an Educational Intervention on Organophosphate Pesticides in the Risk Perception and Chlorpyrifos, Diazinon and Parathion Metabolites Levels in Chilean Rural Schoolchildren**

María Teresa Muñoz-Quezada

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**Abstract:** Background: Organophosphate (OP) pesticides, if not applied with due precautions, can be hazardous to health. There is evidence in the Maule region that rural school children are exposed to OP. Objective: To evaluate the impact that an educational intervention has on the exposure to OP and risk perception of two school communities in the Maule Region. Method: A cross-community randomized trial was applied in schoolchildren from two rural schools in the Maule Region in 2016-2017. The sample size was 48 (24 for each school). The average concentration of OP metabolites chlorpyrifos (CPM), diazinon (Oxy2), malathion (MAM) and paration (PAR) in repeated measurements of urine samples of schoolchildren during a week for two days at the beginning of October and two days was evaluated at the end of November of each year. The risk perception of schoolchildren and their parents before and after the intervention was measured simultaneously. Samples were analyzed at the CDC laboratory (USA). Results: Preliminary results for 2016 are showed here. MAM were below the limit of detection (LOD); while OP of measure 1 were CPM = 1.2g / L and measure 2 CPM = 1.3g / L; measure 1 Oxy2 = 0.09 g / L and measure 2 Oxy2 = 0.4g / L; measure 1 PAR = 0.9 g / L and measure 2 PAR = 1.2g / L. The PAR is banned in Chile since 2000. In multiple linear regression models, CPM metabolites in the urine were associated with fruit at school and application of OP pesticides at home. PAR and CPM were correlated in urine in both measurements ( $p = 0.0004$ ) suggesting that both are applied combined. The educational intervention allowed a greater awareness and knowledge of the risks of OP in schoolchildren and their parents. Conclusion: It is necessary to strengthen the intervention of school communities, involve government entities and agricultural companies, considering that are applying dangerous pesticides without preventing the population, providing guidelines to reduce community exposure.

### **003.03.29. The Nasal Methylome as Biomarker of PM2.5 Exposure in Children**

Andres Cardenas

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**Abstract:** Background: The nasal methylome is easily accessible and in direct contact with the environment, potentially serving as an epigenetic biomarker. Methods: We conducted nasal epigenome-wide association analyses of exposure to ambient fine particulate matter (PM2.5) within the Project Viva cohort among 503 children (mean age 12.9 y). We used residential addresses to estimate daily ambient PM2.5 levels with 1km resolution during the day of sample collection, 7-days and 1-year prior moving average (MA). Trained personnel collected nasal swabs from the anterior nares and DNA methylation (DNAm) was measured using the Illumina MethylationEPIC BeadChip. We tested 701,812 high quality autosomal CpGs conducting CpG-by-CpG and regional DNAm analyses. We adjusted for maternal education, smokers living in the household, child sex, race/ethnicity, BMI z-score, age, season at sample collection, heterogeneity driven by cell-type and accounted for multiple comparisons. Additionally, we evaluated the ability to predict PM2.5 exposure by DNAm marks using LASSO. Results: Mean (SD) PM2.5 levels during the day of sample collection, 1-week, and 1-year prior were 7.44 (3.04), 7.43 (2.02) and 7.76 (0.55)  $\mu\text{g}/\text{m}^3$ , respectively. Adjusted analyses identified 6,220 CpGs associated with 1-year PM2.5 levels (FDR<0.05), including 80 CpGs passing Bonferroni correction ( $P < 7.1 \times 10^{-8}$ ), and 30 differentially methylated regions (FDR<0.05) having 10 or more CpGs. Results included genes previously associated with PM2.5 in an EWAS of adult blood (ANKHD1, ANKRD11). Using 80% of the data for training (N=402), we identified 17 CpGs that moderately predicted 1-year PM2.5 levels ( $r=0.44$ ) in the remaining validation set (N=101). Conclusion: We observed widespread nasal DNAm variability associated with ambient PM2.5 levels 1-year prior to sample collection but no associations with short term levels. The nasal methylome may serve as a sensitive epigenetic biomarker of long-term PM2.5 exposure.

### 003.03.30. Infants' Exposure to Organophosphate Esters (OPES)

Kate Hoffman

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**Abstract:** Organophosphate esters (OPES) are frequently used as flame retardants and plasticizers in consumer products, including those specifically designed for use by infants (e.g. carseats and play mats). Though data suggest nearly everyone is exposed to OPES, exposure levels among infants and the factors associated with higher levels of exposure are largely unknown. As a part of the ongoing CHildren's Immune ResPonse (CHIRP) Study, urine samples were collected from central North Carolina children at 2 and 12 months of age (89 samples from 61 individual children). Using mass spectrometry methods we measured 6 urinary OPE metabolites in samples. Bis(1,3-dichloropropyl) phosphate (BDCIPP) and diphenyl phosphate (DPHP) were detected in 100% of sample and other metabolites were also detected frequently [ $>80$  of samples contained isopropyl-phenyl phenyl phosphate (ip-PPP), bis(1-chloro-2-propyl) 1-hydroxy-2-propyl phosphate (BCIPHIPP), bis(2-chloro-isopropyl) phosphate (BCIPP), and tert butyl-phenyl phenyl phosphate (tb-PPP)]. Median metabolite concentrations were generally substantially higher than those reported for older children or adults. Age was inversely associated with chlorinated metabolites. For example, BCIPHIPP levels were 3.7 times higher at 2 months of age than at 12 months of age ( $10\beta=4.7$ : 95% Confidence Interval: 3.1, 6.2). Breastfeeding was associated with significantly higher BCIPHIPP levels ( $10\beta=1.7$ : 95% CI: 1.2, 2.5) and suggestively higher levels of several other metabolites, indicating that breastmilk may be a source of exposure to OPES. Demographic characteristics were associated with urinary metabolites (e.g. maternal education and race) as was the season of sample collection. Ownership and use of various baby products was also associated with OPE metabolites, but patterns varied by age and metabolite. Cumulatively, results indicate that infants have higher levels of exposure to OPES, raising concerns given infants' sensitivity to environmental insults.

**O03.03.31. Nicotine and Flavor Emissions from Electronic Cigarettes**

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Abstract: Use of electronic nicotine delivery systems (ENDS), such as electronic cigarettes (e-cigarettes), is increasing in the United States and globally. Despite the growing use of e-cigarettes, little is known about the physical and chemical properties of e-cigarette emissions inhaled by the user, and what device, topography, user preferences influence their exposure. The objective was to produce a physiologically relevant e-cigarette aerosol by mimicking the temperature and humidity found in a user's respiratory system. This approach produced an "inhaled" aerosol with more representative physical and chemical properties than sampling directly from the e-cigarette. The output from the system corresponded to the expected aerosol size distribution and chemical composition in the user's lungs. Our experiments characterized aerosol size distribution, nicotine and flavor yield (micrograms per puff) and gas-particle partitioning as a function of liquid type, device settings, and user topography. The aerosol size distribution produced by all liquids were different. We found that elevated humidity and residence time inside the simulated lung activated the growth of condensation nuclei. The resulting aerosol size distribution varied from 100 nm to 220 nm in count median diameter. The aerosol chemical composition changed under humid conditions because the humectants promoted absorption of nicotine and flavorings into the liquid droplets. Device power and puff volume jointly affected nicotine, menthol, vanillin, and benzyl alcohol yield. A statistically significant power function related the device settings and topography to the yield. These initial data provide evidence that exposure to electronic cigarette emissions can be significant. The size distribution and chemical composition of the inhaled emissions vary as with device power and puff volume. This variability could alter the acute and chronic health of electronic cigarette users as their proficiency with using the device increases.

### 003.03.32. Metal Exposure from E-Cigarette Users in Maryland

Angela Aherrera

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**Abstract:** Background As more is known about the components of electronic cigarettes (e-cigarettes), it is important to characterize metal exposure from use. Nickel (Ni) and chromium (Cr) are frequent components of e-cigarette heating coils and have been found in e-liquid and aerosol. We compared Ni and Cr biomarker concentrations among Maryland e-cigarette users to that of non-e-cigarette users/non-smokers, and also assessed the association of e-cigarette use patterns with metal biomarker concentrations. Methods We recruited 50 e-cigarette users and 50 non-e-cigarette users from March to October 2017. Data were collected on health status, e-cigarette use patterns, device characteristics, sociodemographic factors. Urine, saliva, and exhaled breath condensate (EBC) samples were collected. Metal concentrations were measured using ICP-MS. Results The median Cr concentrations for non-users and e-cigarette users were 0.92 and 1.77 µg/l in urine, 0.62 and 0.73 µg/l in saliva, and both 0.14 µg/l in EBC, respectively; median Ni concentrations were 0.68 and 1.11 µg/l in urine, 0.27 and 0.55 µg/l in saliva, and both 0.13 µg/l in EBC. Compared to non-users, e-cigarette users had significantly higher levels of Ni concentration in urine (GMR 3.99, 95% CI: 1.95-8.19,  $p < 0.001$ ). Increased urine Ni concentrations were observed among users who vaped at a higher voltage (3.65-4.20 volts) and used a higher nicotine concentration (12-24 mg/ml). Saliva Cr concentrations were increased with more e-liquid consumed per week (35 to 60 ml). Both Ni and Cr saliva concentrations were increased among users that changed their coils more frequently (>2/month). Conclusion E-cigarette users had significantly higher levels of Cr in urine than non-users. Ni in urine and Cr in saliva were positively associated with higher e-cigarette use and voltage. Increased metal concentrations in saliva associated with more frequent coil change provide an indication that instructions and best practice of using coils is warranted.

### **003.03.33. Temporal Stability of Urinary Cadmium in Samples Collected Several Years Apart in a Population of Older Persons**

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**Abstract:** Objectives: There is growing evidence that urine cadmium is a temporally stable biomarker indicative of long-term cadmium exposure; however questions remain with regard to generalizability to older persons, the impact of changes in smoking behavior, and the degree of temporal stability when repeat sample collection spans years instead of weeks or months. Methods: Using pre-existing samples from male (Osteoporotic Fractures in Men (MrOS-US)) and female elderly cohorts (Study of Osteoporotic Fractures (SOF)), we analyzed two morning spot urine samples each from 39 males and 18 females. We stratified by smoking history and then randomly selected males, who had a mean age of 74, and females who presented with a mean age of 76. For the males, samples were collected approximately 6 years apart, and 4 years apart for the females. Intra-class correlations were computed to assess temporal stability, and adjusted for age and BMI. Results: The median (standard deviation) creatinine-adjusted urinary cadmium levels (0.39 ( $\pm$  0.26), 0.89 ( $\pm$  0.51)  $\mu$ g/g for MrOS and SOF, respectively) were similar to levels expected for these age/sex groups in the US according to the National Health and Nutrition Examination Survey. The intra-class correlation was high (ICC=0.85) and similar between cohorts (MrOS: ICC=0.74; SOF: ICC=0.81). ICCs were similarly high for current smokers (ICC=0.89) and never smokers (ICC=0.82) but slightly smaller among those who stopped smoking between waves of sample collection (ICC=0.68) or among former smokers (ICC=0.64). Conclusions: We report good-to-excellent reproducibility of urine cadmium using morning spot urine samples collected 4-6 years apart from male and female older persons, but slightly smaller correlations among those with a history of smoking who are no longer smoking.

### **O03.03.34. Cadmium Exposure, Active Smoking and DNA Methylation Profiles in Human Blood DNA Samples from the Strong Heart Study**

Arce Domingo Relloso

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**Abstract:** BACKGROUND Experimental studies suggest that exposure to cadmium may alter DNA methylation (DNAm). In addition, DNAm status at several genomic sites has been associated with smoking in methylome-wide epidemiologic studies. Cadmium in cigarettes has been proposed as a causative agent for multiple health outcomes. The objective of this study was to investigate the mediator role of cadmium in the association between smoking and genomic DNAm profiles in 2325 Strong Heart Study participants. METHODS DNAm was measured in 860079 loci using the Illumina Infinium Human MethylationEPIC platform. Data were preprocessed, including correction for batch effect and cell heterogeneity. Cadmium concentrations in urine were determined by Inductively Coupled Plasma Mass Spectrometry, corrected by creatinine and log-transformed. Associations for active smoking on DNAm were estimated using linear regression models adjusted by age, body mass index, sex, with and without cadmium levels when required. We used the "difference of coefficients" method and the mediation R package to estimate the relative contribution of cadmium to smoking-associated DNAm. RESULTS 38.4 % of the participants were active smokers. Median urinary cadmium was 0.97 µg/g. At a Bonferroni significance level of 5.91e-08, we replicated well-known associations of active smoking with DNAm. Among the 1858 significant sites, the top 5 mediated effects (% of association attributed to cadmium) were observed for NFIB (cg03253449, 31.33 %), IFIH1 (cg19965693, 28.9 %), CDC42BPB (cg02003183, 27.71 %), HSD17B12 (cg14262884, 27.19 %) and AHRR (cg00731338, 21.37 %). CONCLUSIONS The association of active smoking and DNA methylation in well-established smoking associated DNAm sites was partially attributed to cadmium. Our results suggest that cadmium might be a partial mediator of the association between smoking and health outcomes through epigenetic mechanisms. These results need to be replicated in an independent study population.

### **O03.03.35. Pattern of Prenatal Secondhand Smoke Exposure among Rural Women in Main Tobacco Production Region, China**

Xia Xiao

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**Abstract:** Background: Prenatal secondhand smoke (SHS) exposure is the most modifiable risk factor associated with adverse birth outcomes. However, few researches were interested in finding the heterogeneity change tendency throughout pregnancy. The objectives of this study were to explore the heterogeneity by classifying subgroups based on the trajectories of urine cotinine (UC) throughout pregnancy in main tobacco production region, so as to provide individual intervention. Methods: This study used a prospective prenatal cohort consisting of 385 pregnant women who were UC validated as passive smoking at first (T1), second (T2) and third trimester (T3) time points. Urine cotinine were analyzed by high performance liquid chromatography-tandem mass spectrometry. The limit of detection for cotinine was 0.08ng/mL. Latent Class Growth Curve Modeling (LCGCM) was used to classify pregnant women into the unobserved subgroup (latent classes) with similar trajectories of UC. Results: The three-class patterns were determined prefer based on the information criteria. The general trends of UC in three patterns were upward with different trajectories from T1. The first class was steep increase at T2 and followed by sharp decrease at T3 (n=7, 1.8%); the second class was flat increase throughout pregnancy (n=98, 24.8%); the third class was moderately rising during pregnancy (n=290, 73.4%). The minority group and residence in tobacco production areas were positively associated with the UC increase trend. Conclusions: Patterns of prenatal SHS exposure among rural women generally go up with different trajectories during pregnancy. The lifestyle of minority and living environment of tobacco production may increase UC level. LCGCM may assist to better understanding the pattern of UC change over time. Identification of three subgroups and their distinctive patterns of change have the potential help for individual intervention.

### **O03.03.36. Polycyclic Aromatic Compounds Identified in Thirdhand Smoke Contaminated House Dust**

Penelope Quintana

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Abstract: Thirdhand smoke (THS) is the residue of tobacco smoke that remains in house dust and on surfaces, and can be re-emitted into air and further react in the indoor environment to create additional compounds. THS-contaminated house dust poses a special risk to children due to their hand-to-mouth behaviors, as well as their vulnerable stage of development. Chemicals already characterized in THS-contaminated house dust include nicotine, tobacco-specific nitrosamines, and polycyclic aromatic hydrocarbons (PAHs). Here we report on the concentrations of a suite of non-traditionally measured polycyclic aromatic compounds (PACs), including oxygenated-PAHs and methyl-PAHs, which may be more toxic than parent PAHs. House dust samples were collected using the HVS3 cyclone vacuum from homes of smokers (n=30) and nonsmokers (n=9) in San Diego, CA, USA, and characterized for a variety of PACs by GCxGC/ToF-MS. Multiple PACs were elevated in dust samples from smokers' as compared to nonsmokers' homes. Of particular note was the detection of 1,2-naphthoquinone (1,2NQ), which was the most highly abundant oxy-PAH, and was elevated in smokers' homes relative to nonsmokers' (median 7822 ng/m<sup>2</sup> vs. 4111 ng/m<sup>2</sup>), though this difference was not significant. 1,2NQ levels were significantly correlated with nicotine measured in the same samples ( $\rho = 0.0374$ ,  $p=0.027$ ), suggesting that this compound may be associated with THS. 1,2 NQ is directly mutagenic and has not been reported before in house dust to our knowledge, though it has been reported in tobacco smoke, PM2.5 air pollution and diesel exhaust. Results indicate that measurement of traditional 16 EPA PAHs may underestimate toxic compounds in house dust, and that thirdhand smoke in house dust may be a source of elevated levels of certain toxic PACs. The compound 1,2 NQ and other PACs in house dust may pose a risk to children and policies should be strengthened to prevent THS exposure in homes.

## O03.03G. Greenness Effects 2

### **O03.03.37. Measurement Error in Epidemiological Studies of Allergenic Pollen Due to Heterogeneity in Flowering Phenology**

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Abstract: Most epidemiological studies of allergenic pollen compare daily measurements from a pollen monitoring station with health outcomes from across a city or region, implicitly assuming that pollen is released at the same time across the study areas. However, cities contain temperature gradients that could cause trees in some neighborhoods to flower substantially earlier or later, potentially resulting in differences in airborne pollen concentrations between the regional pollen monitoring station and neighborhoods within the study area. The resulting pollen exposure measurement errors could be large and may result in substantial bias. In this study, epidemiological studies of allergenic pollen are reviewed and temperature gradients within their study areas are quantified. In addition, the effects of an intra-urban temperature gradient on flowering time and airborne pollen concentrations were measured in an observational study conducted on oak and mulberry trees in Detroit, USA. In the epidemiological studies, 50% of study areas were not within 1° C of the pollen measurement location. In the field study, a difference of 1° C resulted in 4 and 10 days difference in flowering time for oak and mulberry. Airborne pollen concentrations were correlated with estimated flowering time for oak ( $R^2 = 0.25$ ,  $p < 0.001$ ) and mulberry ( $R^2 = 0.68$ ,  $p < 0.001$ ) but were only weakly correlated with pollen concentrations measured at the pollen monitoring station for oak ( $R^2 = 0.07$ ,  $p > 0.05$ ) and mulberry ( $R^2 = 0.04$ ,  $p > 0.05$ ). These results provide evidence of intra-municipal heterogeneity in tree flowering and differences in airborne pollen concentrations between neighborhoods within a metropolitan area and the regional pollen monitoring station. This cautions against using measurements from a single pollen monitoring station as a proxy for pollen exposures if the study area contains climatic variability.

### **003.03.38. Human Responses to Biophilic Indoor Environment**

Jie Yin

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**Abstract:** Biophilic design, which incorporates natural elements into the built environment, has received increasing attention in both design and health fields. Epidemiological and experimental studies have provided sufficient evidence that contact with outdoor nature has positive impacts on human health and wellbeing. However, the potential for similar health benefits in indoor biophilic environments remains unclear. We designed a randomized crossover study to examine the physiological and cognitive responses to biophilic indoor environments by using virtual reality (VR) and wearable bio-monitoring sensors. In this study, 28 participants spent time in an indoor environment featuring biophilic design elements and one without, with the order of the visit randomized. In each visit, they experienced the same environment for 5-minutes in reality and virtually by using VR. The indoor biophilic environment was associated with a decrease in participants's blood pressure. The overall differential effects for participants experiencing an indoor environment with biophilic elements versus none was 8.56 (95%CI: 5.60-11.52) mmHg lower systolic and 3.57 (95%CI: 0.36-6.78) mmHg lower diastolic blood pressure. In addition, their skin conductance decreased by 0.18 (95%CI: -0.004-0.36)  $\mu$ S and short-term memory improved by 14% (95%CI: 5.3%-23.2%). Moreover, our findings indicate that participants had similar physiological and cognitive benefits in the virtual environment and actual environment. The results indicate that biophilic environment may be beneficial in reduce stress in indoor settings. Additionally, the parity in results in virtual and real environments provides evidence that using VR can be an effective tool to simulate visual exposures when access to the real environment is not feasible.

### **O03.03.39. Built Environment, Microbiota and Asthma at Age 3: Longitudinal Follow-Up in a Canadian Birth Cohort**

Hind Sbihi

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**Abstract:** Background The Canadian Healthy Infant Longitudinal Development (CHILD) birth cohort was designed to define factors related to the development of asthma. We examined modifiable environmental exposures and gut microbiota with respect to asthma incidence. Methods Stool samples collected at 3 and 12 months from an asthma-enriched CHILD subset (n=999) were profiled with 16S rRNA sequencing. Mothers' built environment was assessed at their residential addresses with a satellite measure of greenness (NDVI) and land use regression models to derive nitrogen dioxide (NO<sub>2</sub>) individual estimates of traffic-related air pollution (TRAP). Data were collected on intrinsic risk factors, including parental asthma status, mode of delivery, parity, socio-economic factors, and antibiotic use. We examined the association of gut microbiota composition with environmental factors and their impact on asthma at age 3yrs. Results Children with asthma at 3 years (n=312) had higher exposure to NO<sub>2</sub> (mean (SD): 16.1 (7.2) ppb) and lower exposure to greenness (NDVI mean (SD): 0.25 (0.08)) compared to those without asthma (NO<sub>2</sub>: (14.7 (6.8) ppb); NDVI: 0.26 (0.08)). Children with asthma were more likely to have atopic primiparous mothers who were prescribed antibiotics during pregnancy. While microbiome alpha diversity increased between 3 months and 1 year, maternal atopy (p=0.06) and prenatal TRAP exposure (p=0.05) were negatively associated with this trend. Infants diagnosed with asthma by 3yrs had different microbiota composition at 3 months (p=0.002), including reduced *Oscillospira* colonization (FDR p<0.05). Prenatal TRAP exposure also accompanied shifts in beta-diversity at 3 months (p=0.002) and was negatively correlated with *Oscillospira* abundance (spearman r=-.13; FDR p<0.01). Conclusions Increased alpha diversity and *Oscillospira* abundance-known health protective features of the microbiota-were negatively associated with TRAP which is a key modifiable environmental risk factor.

### **O03.03.40. Spatial and Temporal Associations between Allergic Rhinitis, Asthma and the Environment in Toronto, Canada**

Jordan Brubacher

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Abstract: Exposure to various plant pollen and fungal spores contribute to asthma and allergic rhinitis (AR) exacerbations and may cause these chronic illnesses to develop. These organisms interact with the weather, which influences production, timing and dispersal of their airborne glycol-proteins. We describe associations between weather, pollen, spores, air pollution, AR and asthma in Toronto, Canada in order to gain a better understanding of possible future trends under a changing climate. We also describe spatial associations between land cover and these health outcomes to better understand how urban form may be related to respiratory health. Exposure estimates were derived from aeroallergen and air pollution monitors, and health outcomes were characterized using the number of Toronto residents who accessed health services for AR and asthma between 2004 and 2014. A separate analysis investigated associations between aeroallergens and weather using various time lags to account for the complex relationships between weather and biota. Geographic weighted regression was used to investigate the spatial relationships between these diseases and tree canopy cover, distance to Lake Ontario and building height, and spatial scan tests were used to identify clusters. Significant associations ( $p < 0.05$ ) were observed between air pollutants, multiple taxa of plant pollen, and both allergies and asthma. There was 70.5 and 61.2 percent deviance explained in the AR and asthma spatial models, respectively. Areas with higher AR and asthma were associated with less tree cover, greater distance from the lake and shorter buildings. Spatial scan tests identified hot spots that remained constant from season to season. Social deprivation will be added as a covariate (analysis underway). These findings can inform opportunities for illness prevention as weather patterns and ecologies shift with climate change.

### **003.03.41. Greenness and Adverse Pregnancy Outcomes in Tel-Aviv during 2000-2014**

Keren Agayshay

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**Abstract:** Background: Longitudinal evidence of beneficial associations between exposure to greenness and pregnancy outcomes are limited. Our objective was to evaluate these associations among 78,671 livebirths in Tel Aviv, Israel. Methods: longitudinal exposure to mean greenness during pregnancy and trimesters were calculated using satellite-based Normalised Difference Vegetation Index (NDVI) from MODIS 8-days interval data. In addition, exposure to mean NDVI from high-resolution satellite (RapidEye) and percent of tree cover (Vegetation Continuous Fields (VCF)) at various radii (100m, 300m and 500m), were evaluated in a cross-sectional approach. Generalized linear models were used to evaluate the associations between greenness and pregnancy outcomes in crude and adjust models. Results: In models adjusted for individual and neighborhood-level markers of socioeconomic status (SES), highest tertile of exposure to mean NDVI during pregnancy was associated with a statistically significant increase in birth weight (3rd/1st tertile increased mean birth weight in 13.2 g 95% CI: 5.0, 21.4) and decreased odds of very preterm delivery (PTD) (3rd/1st tertile OR: 0.80, 95 %CI: 0.64, 1.00). The strongest associations for birth weight observed during the first trimester and for very PTD during the second trimester. Associations for the cross-sectional approach were similar and in addition decreased odds of small for gestational age (SGA) and low birth weight (non-linear associations) were observed. Associations with NDVI were stronger than the associations with tree cover. Associations were consistent for further adjustment and stronger for low SES. Conclusion: Consistent beneficial associations using different greenness measures and approaches are reported. Further studies should use the longitudinal approach because it allows us to understand when exposure during pregnancy to green environment is the most beneficial for pregnancy outcomes.

### **O03.03.42. Association between Green Space and Pregnancy Outcomes: A Case-Study in Temuco, Chile. Preliminary Results**

Maria Quinteros Caceres

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**Abstract:** A rapidly growing body of research has recently shown beneficial health effect of urban green environment and natural spaces. Latin America is the world's most urbanized region, with largest social and economic inequities, facing important challenges in city design, and availability of green spaces. Here, we examine the association between residential surrounding greenness and pregnancy outcomes in a Temuco, a mid-size city in Chile. To our knowledge, this is the first study of this kind in Latin America. A retrospective cohort is being conformed using pregnancy records from the main public Hospital in Temuco during 2009 - 2016, including sociodemographic and medical inputs. Pregnancy outcomes included: preeclampsia and gestational diabetes, for the mother; and preterm birth, low birth weight, term birth weight, small for gestational age, birth weight, gestational age and head circumference, for the newborn. Home address was georeferenced using the Google map geocoding API. Greenness was estimated for each address by using the NDVI from satellite data in buffers of 100, 300 and 500m. Separate logistic multivariate models were fitted for each outcome adjusted for potential confounders. Effects were estimated for changes in one interquartile range (IQR) in surrounding greenness. From expected 16,000 total records, preliminary results are shown for the first 9800 (2009-2013). Overall, analyses show decreased risks of gestational diabetes (OR 0.97 IC95% 0.85 - 1.10 for 300m buffer), preterm birth (OR 0.94 IC95% 0.78 - 1.15 for 300m buffer), low birth weight (OR 0.94 IC95% 0.77 - 1.16 for 300m buffer), and small for gestational age (OR 0.99 IC95% 0.86 - 1.13 for 300m buffer) associated with an IQR increase in NDVI. Preliminary findings point to beneficial impact of surrounding greenness in fetal growth, although not reaching statistical significance. Analysis will be repeated once data entry is complete (end of April).

## 003.03H. Health Outcomes and Biomarkers Associated with Household Cooking and Biomass Burning 1

### **003.03.43. Biomonitoring Exposure to Household Air Pollution in Children: Results from a Cook Stove Intervention Study in Kenya**

Zheng Li

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**Abstract:** Background: Indoor biomass stoves are common in developing countries. Such stoves release harmful pollutants such as polycyclic aromatic hydrocarbons (PAHs) and lead to household air pollution (HAP). HAP disproportionately affects women and children because they spend more time at home near stoves. In 2012, we conducted a cross-over study in two Kenya villages to investigate HAP exposure in households with traditional three-stone stoves and six different improved stoves. We report HAP exposure among children living in the households by biomonitoring PAH biomarkers in urine. Method: Forty-five households using only traditional stoves participated in the study and tested up to six new stoves (two-week usage/stove, one-week break). We collected urine samples from the youngest children (4 years or younger, 25 boys and 19 girls) in each household at baseline (n=44) and at the end of each period after using an improved stove (n=29-34). Up to two urine samples were collected on two consecutive days from each child, resulting in 81 urine samples at baseline and 51-61 samples at each period. We measured 9 hydroxy PAHs (OH-PAHs)-metabolites of naphthalene, fluorene, phenanthrene and pyrene-in 417 urine samples. Results: Median urinary OH-PAH concentrations in this study were 5-22 times higher than that of the U.S. children (6-11 years) from NHANES 2011/12. For example, median 1-hydroxypyrene was 2.0 pg/L (fresh weight), which was 16 times higher than that of the U.S. children (0.127 pg/L). Among the improved stoves, using the Ecochula (an electric fan-assisted gasifier) and Prakti (a double-pot rocket with chimney) showed the largest reduction of median urinary OH-PAH levels in children (averaging 28% and 21% reduction, respectively) compared to using traditional 3-stone stoves. Conclusion: Several stoves showed a moderate reduction in urinary PAH biomarker levels among children. Even with the improved stoves, HAP exposure in this study is high compared to the U.S. children.

### **O03.03.44. Effect of Biomass Fuel Exposure on Pregnancy Outcomes in Rural Bangladesh**

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Abstract: Low birth weight is a major cause of infant morbidity and mortality in low-income countries like Bangladesh. Emerging data suggest that exposure to biomass fuel (BMF) smoke, common during cooking with BMF, might affect birth weight. Here we investigated whether exposure to BMF smoke is associated with pregnancy outcomes in rural Bangladesh. As part of the Cook Stove Study of Bangladesh (CSSB) we recruited 903 pregnant women within 6-18 weeks of pregnancy. Detailed sociodemographic, health, diet, and pertinent exposure data (type of fuel used, duration of cooking, kitchen type and others) were collected by trained interviewers. Anthropometric measurements of the newborns (N=797) were done by field personnel within 24-72 hours of delivery. This analysis was restricted to newborns born within 37-42 weeks of gestation (N=736). Participants who used coal, wood, leaves, agricultural residues, or cow dung were categorized as solid fuel users (n=602). We fitted a multivariable linear regression model to assess the effect of exposures of interest on birth weight, length and head circumference after adjusting for gestational age, and maternal age, BMI, diabetes status and hypertension. The mean ( $\pm$ SD) birthweight of the newborns was 2736 gm ( $\pm$ 370gm). Almost 82% of the women used solid fuel for cooking and spent on average 3.32hrs ( $\pm$ 1.8hrs) for cooking. We observed a statistically significant interaction for the use of solid fuel and duration of cooking on birth weight ( $p=0.03$ ) and marginally significant interaction on birth length ( $p=0.1$ ). Based on hour model coefficients, 3.32 hours of cooking with solid fuel can lead to a 145gm reduction in birthweight, compared to a woman who does not cook or spend time in the kitchen during cooking. Exposure of pregnant women to solid fuel smoke during cooking has a detrimental effect on birth weight of the newborn.

### **003.03.45. Acute Respiratory Symptoms and Risk Factors in Pregnant Women Cooking with Biomass Fuels in Rural Ghana**

Eleanne van Vliet

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**Abstract:** **BACKGROUND:** Eighty-three percent of the population in Ghana relies on biomass fuels for cooking and heating needs. Household air pollution (HAP) emitted from the incomplete combustion of these fuels has been associated with adverse health effects including respiratory effects in women that can lead to chronic obstructive pulmonary disease (COPD), a major contributor to global HAP-related mortality. **OBJECTIVE:** This study assessed the prevalence of respiratory symptoms, as well as associations between respiratory symptoms and HAP exposure, as measured using continuous personal carbon monoxide (CO), in nonsmoking pregnant women in rural Ghana. **METHODS:** We analyzed acute respiratory health symptoms and CO exposures upon enrollment in a subset (n=840) of the population of pregnant women cooking with biomass fuels and enrolled in the GRAPH randomized clinical control trial. Personal CO was measured using Lascar real-time monitors. Associations between CO concentrations as well as other sources of pollution exposures and respiratory health symptoms were estimated using logistic regression models. **CONCLUSION:** There was a positive association between CO exposure and a composite respiratory symptom score of current cough (lasting > 5days), wheeze or dyspnea (OR: 1.2, 95% CI: 1.02, 1.45). CO was also positively associated with wheeze (OR: 1.3, 95% CI: 1.00, 1.63). Adjusted multivariate models showed significant associations between environmental (second-hand) tobacco smoke (ETS) and the composite outcome (OR: 2.1, 95% CI: 2.0, 3.5), and individual outcomes of cough>5 days (OR: 3.1, 95% CI: 1.31, 7.23), wheeze (OR: 2.7, 95% CI: 1.44, 5.15) and dyspnea (OR: 2.2, 95% CI: 1.19, 3.97), although fewer women were exposed to ETS. Results suggest that exposures to HAP and ETS increase the risk of adverse respiratory symptoms among pregnant women using biomass fuels for cooking in rural Ghana.

### 003.03.46. Examining the Relationship between Household Air Pollution and Infant Nasal Carriage

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**Abstract:** Background/Aim: Pneumonia, the leading cause of childhood mortality worldwide, is associated with household air pollution (HAP) exposure. Mechanisms between HAP and pneumonia are poorly understood, but the Randomized Exposure Study of Pollution Indoors and Respiratory Effects trial in Guatemala identified severe pneumonia as more likely of bacterial, rather than viral, etiology. Our research seeks to confirm relationships between HAP and infant bacterial carriage, specifically among those diagnosed with pneumonia. Methods: Data were collected through the Ghana Randomized Air Pollution Study (GRAPHS), which recruited mother-infant pairs until the child's first birthday. Improved biomass, LPG, or 3-stone (baseline) cookstoves were randomly assigned to participants. The current analysis is restricted to LPG and 3-stone arms. Carbon monoxide (CO) exposures were measured for each infant and fieldworkers conducted surveillance for pneumonia. Cases were sent for treatment and nasopharyngeal swabs. Age and sex-matched controls were swabbed. Swabs were analysed with MassTag PCR for common infections. Statistical analyses included group-wise comparisons of microbial pathogens by study arm. At study completion, the association between CO-levels and specific microbes will be analysed. Results: Preliminary analysis demonstrates participants in the 3-stone arm have higher microbial levels than the LPG intervention arm ( $p < 0.0001$ ) ( $N=198$ ). This difference appears driven by bacterial ( $p < 0.0001$ ) rather than viral levels (non-significant) among 3-stone participants. Bacterial-level differences are consistent when stratifying by cases ( $p < 0.0001$ ) and controls ( $p = 0.0049$ ). Forthcoming analysis will assess the effects on specific microbe species. Conclusions: Findings could strengthen knowledge of pneumonia etiology. Childhood pneumonia is a grave public health concern and these data could inform public health efforts, including HAP interventions or vaccination programs.

### **003.03.47. Exposure Profiles of Cooking Behaviors, Socioeconomic Status, and Housing Characteristics Are Strongly Associated with Childhood Asthma in Kampala, Uganda**

Eric Coker

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**Abstract:** Despite the known health risks of household air pollution (HAP), less is known about how cooking behaviors and housing characteristics cluster to determine health risks. We performed a case-control study of children under 15 years of age presenting with cough at health centers in Kampala, Uganda (n=607) from January-March, 2018. Among homes who cook with a polluting fuel (charcoal, wood, kerosene), we applied Bayesian Profile Regression and identified exposure profiles of cooking-related behaviors, socioeconomic status (SES), and housing characteristics associated with asthma (current wheeze and at least one other asthma symptom). Compared to a referent exposure profile, characterized by cooking outdoors and low SES, the odds of asthma were significantly higher (OR 9.7, 95%CI 4.9-21.3) in an exposure profile characterized by high proportions who cook in a room unattached to the home or in a kitchen in the home, a room with no windows, with children indoors during cooking, who use a polluting fuel for lighting, and with low SES and low crowding. Odds of asthma were significantly higher (OR 3.37, 95%CI 2.10-5.65) in an exposure profile characterized by high proportions who cook in the main sleeping area that has windows, with children indoors during cooking, who use a polluting fuel for lighting, and with low SES and high crowding. The odds of asthma (OR 1.58, 95%CI 0.96-2.63) were similar to the referent in an exposure profile characterized by high proportions who cook in a room unattached to the home or in a kitchen in the home, a room with windows, with children outdoors during cooking, who use electricity for lighting, and with high SES and low crowding. Our analysis suggests that cooking behaviors, SES, and housing characteristics exhibit clustering patterns that are associated with higher odds of asthma. Design of cookstove interventions to reduce HAP and associated asthma should consider interactions among a combination of social, behavioral, and housing factors.

### **O03.03.48. Inflammatory Effects of Short-Term Exposure to Smoke Emissions from Biomass Fuels**

Binaya Kc

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**Abstract:** Short-term exposure to household air pollution (HAP) has been linked with increased respiratory symptoms including cough and breathlessness. More prolonged exposure to particulate matter and other toxic chemicals from biomass combustion worsens health outcomes and may lead to premature death. Airway inflammation following exposure to inhaled pollutants is likely to be a key step in this process. The present study aims to evaluate the inflammatory effects of short-term exposure to biomass smoke extract on human bronchial epithelial cell and ex vivo human lung tissue by measuring a range of inflammatory markers. Biomass smoke samples were collected during cooking periods in rural households from four different regions of Nepal located at the various altitude ranging from 200 m to 3900 m above sea level. Cultured human bronchial epithelial cells and an ex vivo human lung explant model were stimulated with the smoke extract samples. Inflammatory responses were assessed in cell and tissue culture supernatant after 48 hours stimulation using Luminex analysis to measure levels of 21 chemokines, growth factors and cytokines. Initial results with samples from one site showed that exposure to biomass smoke extract is proinflammatory resulting in the production of significant amounts of inflammatory markers including IL-8, IL-6, TNF- $\alpha$ , GM-CSF and IL-1 $\beta$ , with  $\sim$ 4.5 fold increase in IL-8, IL-6, GM-CSF and a 34 fold increase in TNF- $\alpha$  in epithelial cell cultures. Similarly, in lung tissue, the fold increase for IL-8, IL-6, GM-CSF and IL-1  $\beta$  was  $\sim$ 1.5 fold and for TNF-  $\alpha$  was 4 fold. Current experiments are focusing on the potential effects of altitudinal variation on the biomass smoke extracts used to measure these responses. However, our preliminary data indicate that short-term exposure to biomass smoke causes airway inflammation and suggest this effect may underlie the association seen in epidemiological studies between HAP and respiratory diseases.

## S03.03A. Filling in the Gaps: Maximizing Data Linkages to Enhance Environmental Health Studies

### S03.03.01. Enhancing a Historical U.S. Industrial Emissions Database for Exposure Modeling

Rena Jones

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**Abstract:** Background: Regulatory databases can provide a useful framework for environmental exposure assessment, but may lack information needed to estimate exposures for epidemiologic studies. Methods: We previously implemented multiple strategies to verify facility locations in a U.S. regulatory database of industrial polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDD/F)-emitting sources (N=4,478). Recent efforts used geographic information systems and deep learning methods to extract information from aerial and satellite imagery and other resources to characterize smokestack features for future exposure modeling. To estimate smokestack height, we processed a sample of image pairs and queried the output of a digital surface model to derive height above ground. We validated these results via manual comparison to available imagery and other reference materials. Linkages to publicly available ancillary datasets (e.g., meteorology) are ongoing. Results: Overall agreement in smokestack location between multiple previous reviews was >83%. Preliminary efforts to estimate smokestack height using photogrammetry indicate good feasibility for this approach (elevation of the stack, ground, and neighboring structures within expectation compared to reference), although some manual adjustment was required to account for tall buildings exceeding the local topographic variation. Next steps include training a deep learning model to automate this process for the entire database. We will discuss challenges and practical implications of these efforts for a case-control study of non-Hodgkin lymphoma in 4 areas of the U.S. Conclusion: We have verified and supplemented key exposure-related information in a database of PCDD/F sources, improving its utility for epidemiologic studies. Further enhancements may leverage available multi-dimensional data and automated building feature detection and extraction on a larger scale.

### **S03.03.02. Modeling Nitrate Concentrations in Private Wells Using Machine Learning Methods**

Mary Ward

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**Abstract:** Background: Water sampling in large cohort studies is usually not feasible. Public water supplies are monitored but data for private wells are sparse. Methods: We developed models to predict nitrate in private wells for the Agricultural Health Study, a cohort of farmers and their spouses in Iowa and North Carolina (NC). About 60% of the cohort used private wells for their drinking water at enrollment in 1993-97. In Iowa and NC respectively, 34,084 and 22,059 nitrate measurements were available through programs for private well owners and water quality surveys. We split the data into training and testing sets to fit and evaluate both continuous and classification models of nitrate concentrations in each state. Input variables included well depth, land use, nitrogen inputs, soil and aquifer characteristics, distance to sinkholes, animal feeding operations (AFOs), meteorology, and other factors. We compared prediction performance of several modeling approaches including random forests, regression trees, and kriging. Results: In both states, a random forest model performed best. In Iowa, the most important predictor of nitrate was well depth; other important variables included distance to nearest sinkhole, soil and aquifer characteristics, distance to nearest AFO, and agricultural land area within 1 km. The final model contained 66 variables. Based on testing data, sensitivity was 67% and specificity was 86% for a 5 mg/L NO<sub>3</sub>-N cut point, ½ the regulatory limit. Thirteen percent of Iowa participants' wells were >10 mg/l. Nitrate concentrations in NC wells were lower than in Iowa and there were fewer predictor variables available. However, we found similar important variables such as well depth, land use, AFOs, and soils. Conclusions: Modeling water contaminants in epidemiologic studies is feasible but local predictors of nitrate in groundwater are key to model performance.

### **S03.03.03. Investigating Multiple Chemical and Contextual Exposures in the Nurses' Health Studies**

Francine Laden

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Abstract: The Nurses' Health Study and Nurses' Health Study II are U.S.-based prospective cohort studies with decades of follow-up obtained using mailed questionnaires administered every two years. The resultant updated residential address history provides an opportunity to assess health effects of multiple environmental and contextual risk factors in adulthood. We have added numerous residence-level spatiotemporal data on chemical and contextual exposures to the detailed individual-level personal exposures collected on the questionnaires. To date, we have taken advantage of publically available data, purchased data processed by third parties, and developed sophisticated spatiotemporal models at various scales to assess levels of air pollution, temperature, ultraviolet radiation, greenness, walkability, population density, and socioeconomic factors. We also have assessed spatial variation in light at night (LAN), noise, dioxin emissions, and radon. Our breadth of environmental and contextual variables is continually expanding as new data sources come to our attention at higher spatial and temporal resolutions or as new exposures emerge. This georeferenced resource has opened up new opportunities to study environmental etiology of a host of chronic diseases, information on which is obtained originally by self-report during routine follow-up, supplemented by targeted questions and medical record review as appropriate. In this presentation, we discuss the opportunities and challenges of linking environmental and contextual variables to an existing epidemiologic cohort, potential measurement error concerns, as well as approaches to consider these exposures simultaneously with each other and other lifestyle and social variables.

### **S03.03.04. Investigating the Role of Environmental Exposures in Prospective Cohorts: The German National Cohort**

Alexandra Schneider

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Abstract: The German National Cohort is a multicenter study prospectively assessing the health of 200,000 adults aged 20 to 69, recruited since 2014 and re-examined starting in 2019. Currently, more than 150,000 participants have been recruited in 18 study centers within Germany as of March 2018. The study centers serve major urban areas (i.e. Berlin), mid-size regional centers (i.e. Augsburg) and often are expanding into the surrounding rural counties. As part of a "data freeze", data of the first 100,000 participants is currently undergoing quality assurance. Use of address data to integrate georeferenced information and biomaterials from external databases will be discussed. These databases include modelled air pollution, microclimates, UV, greenness, built environment, and noise. These data are part of already collected databases within national and European programs or will be collected in dedicated programs.

### **S03.03.05. Residential History Construction and Application to Etiologic Studies of Environmental Hazards: Lessons Learned**

Peggy Reynolds

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**Abstract:** Large-scale environmental epidemiologic studies often rely on exposure estimates that are based on linkage of residential addresses to georeferenced environmental data. This approach is often limited by a lack of residential histories. This limitation is particularly problematic for the study of diseases such as cancer for which the time period of greatest etiologic relevance may be decades prior to diagnosis. Moreover, for some cancers, such as breast cancer, there are likely certain windows of susceptibility during which women may be especially vulnerable to the toxic effects of environmental hazards. As part of a larger effort to evaluate breast cancer risks associated with a number of environmental hazards in a large on-going breast cancer study, we explored a variety of approaches to construct residential histories. These efforts were undertaken in the California Teachers Study (CTS), a prospective cohort comprised of over 124,000 women living throughout California. Approaches for constructing residential histories included probabilistic record linkages of CTS participants to credit reporting data, statewide vital records data, and county marriage data. For CTS participants who were born in California, California birth records were used to identify where women were born. For the subset of parous women, linkages to birth data were additionally used as a means to identify where women lived at the time they gave birth. Linkages to county marriage data were used to harvest additional surnames to help overcome obstacles posed by surname changes associated with changes in marital status. While these efforts were successful in helping to build residential histories for women prior to entry into the cohort, including for certain critical windows of susceptibility for breast cancer (e.g., during pregnancy and their own pre-/peri-natal development), substantial limitations were encountered. Advantages and limitations of these strategies will be discussed.

S03.03B. Global Environmental and Occupational Health Hubs: Building Sustainable Research Capacity and Collaboration in Low- and Middle-Income Countries to Address Priority Health Threats

**S03.03.07. Neurotoxicant Exposures in Mother/Child Dyads in Suriname: The Caribbean Consortium for Research in Environmental and Occupational Health (CCREOH)**

Firoz Abdoel Wahid

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**Abstract:** Background Suriname, an upper middle-income Caribbean country, faces a triple public health burden: high perinatal mortality, environmental contamination with mercury and pesticides, and a lack of environmental policies. CCREOH examines the impact of exposures to neurotoxicants in 1000 mother-child dyads on birth outcomes and pediatric neurodevelopment. Methods Environmental epidemiologic cohort design, examining the cumulative impact of chemical and non-chemical stressors on birth outcomes and early childhood neurocognitive development. Recruitment sites: Paramaribo, Nickerie, interior. Environmental assessments: Hg, organophosphate pesticides; biospecimen analysis (blood, urine, hair, saliva, cordblood) and psychosocial questionnaires administered at selected trimesters. Neurocognitive and biospecimen analyses at child ages 12, 24, 26, and 48 months. Results Hg hair analysis: N=347: Paramaribo (266), Nickerie (56), interior (25); median levels 0.6 µg/g, 0.7 µg/g, 2.1 µg/g respectively. Interior Hg levels were significantly higher than in Paramaribo or Nickerie (p<0.001). Urine pesticide analysis (N=50): median diethylthiophosphate (DETP) levels of 0.56 ug/L. Of 650 women, 25.7% had EPDS scores ≥12. Women with no education, primary or lower secondary education 2x likely to have EPDS scores ≥12 compared with upper secondary and higher educated women. Endosulfan and lindane residues were present in the most consumed leafy vegetable Tannia. Non-urban and lower educated women had higher tannia intake rates. Discussion Hg levels in interior pregnant women are considerably higher than their coastal peers likely due to Hg-contaminated fish consumption. The number of women with detectable DETP levels was high compared to NHANES standards. Long-term exposures to neurotoxicant mixtures can harm the mother-child dyad.

### **S03.03.08. The Geohealth Program in Peru, with Some Preliminary Results from a Project on Clean Cookstoves**

Magdalena Fandiño Del Rio

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Abstract: The GEOHealth program in Peru with links to Bolivia and Ecuador, responds to training and research needs of the region. The main training activities consists of short, medium, and long term educational opportunities for more than 40 environmental health researchers. The research involves 3 projects: 1) predicting the areas in Peru where infant diarrhea will be most increased due to climate change through models that combine rotavirus vaccination, access to water/sanitation, temperature, and poverty data; 2) a time-series study of cardiorespiratory emergency room visits in Lima in relation to outdoor air pollution, using an air quality model which predicts spatially resolved fine particulate matter (PM<sub>2.5</sub>) based on ground observations, satellite remote sensing data, and land use information; and 3) our study on household air pollution in relation to cardiovascular outcomes, within a clean fuel intervention trial. Household air pollution is a leading risk factor for preventable diseases and among the largest environmental contributors to the global disease burden. Previous interventions with improved cookstoves have not markedly lowered PM<sub>2.5</sub> and shown only limited improvements on health. As a result, recent efforts are focusing on cleaner fuels such as liquefied petroleum gas (LPG). A randomized controlled field trial of a clean cookstove intervention is enrolling 180 female participants and providing free LPG stoves and fuel to 90 participants. We are collecting 48-hour measurements of indoor air concentrations of PM<sub>2.5</sub> in the kitchen. Preliminary data shows daily average kitchen PM<sub>2.5</sub> concentrations of 500 µg/m<sup>3</sup> for baseline emissions of biomass fuel users (n=70). We observed reductions of about 90% for PM<sub>2.5</sub> concentrations inside the kitchen after 3 months of LPG stove use (n=20). Results of this trial will inform the feasibility of LPG stove replacement programs to reduce HAP and improve health in resource-limited settings such as Peru.

### **S03.03.09. The Michigan-West Africa Geohealth Hub: Environmental Exposures Due to Informal E-Waste Recycling Activities and the Health of Workers**

Julius Fobil

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**Abstract: Overview:** The West Africa-Michigan CHARTER II GEOHealth Hub, jointly funded by the US NIH/FIC and Canada's IDRC, integrates research and research training activities of West African Anglophone and Francophone institutions, with support from the University of Michigan and McGill University. **Research Goal:** To increase multi-disciplinary understanding of the risks associated with waste recycling, and to use study findings to inform evidence-based implementation activities and policy options at multi-levels. **Specific Objectives:** Include: 1) characterize work-related, time-varying, job-specific exposures of electronic waste recycling workers at the Agbogbloshie site, and assess biological markers of dose, to metals, organic compounds, and markers of combustion products; 2) provide estimates of potentially increased lifetime, work-exposure-associated cancer risks; and, 3) evaluate associations of exposures with measures of acute and chronic respiratory morbidity in workers. **Methodology:** A longitudinal design in which we enrolled a combined total of 151 study participants over a 3-week period. We collected and are analyzing, repeated measures across seasons for each participant: 1) biological samples for a) metals, b) organic compounds including flame retardants, polycyclic aromatic hydrocarbons, dioxin-related compounds, and 2) personal air monitoring, through a combination of real-time measurements and analysis of size-specific samples collected on filters, including markers of combustion products. **Results:** Preliminary filter-based data show that e-waste workers have breathing zone PM<sub>2.5</sub> concentrations of  $135 \pm 188 \mu\text{g m}^{-3}$  (mean  $\pm$  st. dev.,  $n = 89$ ) compared to  $45 \pm 18 \mu\text{g m}^{-3}$  ( $n = 43$ ) of controls; these worker exposures are considerably higher than levels obtained using area monitoring at the waste site, e.g.,  $84 \pm 24 \mu\text{g m}^{-3}$  ( $n = 9$ ). Based on real-time measurements, burning tasks resulted in exceptionally high PM<sub>2.5</sub> exposures.

### **S03.03.10. Eastern African Geohealth Hub: Overall Status and Research Findings from Ethiopia and Uganda**

Abera Kumie

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Abstract: The GEOHealth Hub for Eastern Africa is tackling growing challenges from environmental and occupational health hazards through research on air pollution in Ethiopia, Uganda, Rwanda and Kenya. In each country, Children's Health Studies (CHS), modeled after the Southern California Children's Health Study, and daily mortality/morbidity time series studies are being conducted. These activities are co-ordinated with training workshops around health/exposure assessment and data analysis and also mentored training to cohorts of African scientists. We present findings from the just completed CHS in Addis Ababa, Ethiopia, and initial findings from the ongoing CHS in Kampala, Uganda. Both studies followed a multi-level design based on school-children from ten sub-cities, representing a diverse pollution profile due to variations in levels of traffic-related, industrial and indoor pollution sources. In Ethiopia, lung function tests (LFT) were performed at schools on 1086 children, 88.5% of whom had completed the LFT, out of which 89.4% had acceptable performance. About 97% of the tested children had FEV1/FVC >70%, 88% > 80%. Based on questionnaires (n=969), mean age was 10 years (SD=1.0; Range=9-13) with 55% females; majority of mothers have no education (80%), while 54% and 80% of mothers and fathers, respectively, were employed. The proportions of reported respiratory illness were generally low and varied by typology. Charcoal and electricity are the most common types of fuel for all meals while Injera baking mainly involved electricity and wood. Most households (78%) used charcoal for traditional coffee ceremony. The child was present at 61-91% of homes during cooking. PM2.5 levels were measured at study schools using E-samplers and showed wide spatial variations. Household air pollution levels are measured using fixed and personal monitors at strategically selected sites of 30% of homes to enable spatio-temporal modeling for estimation of exposure for all study homes.

### **S03.03.11. Establishing a Hub for Environmental and Occupational Health Research and Capacity Building in India**

Prabhakaran Dorairaj

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Abstract: In the last 25 years, India has experienced rapid economic growth, industrialization and urbanization, which has resulted in high levels of air pollution exposure across major urban centres. The World Health Organization's list of cities with the highest levels of ambient air pollution regularly features over a dozen Indian cities in its top 30, and the Global Burden of Disease estimates rank air pollution exposure among the most important risk factors contributing to poor health outcomes in Indians. Till date, however, much of the research on ambient air pollution and health outcomes, specifically on NCDs has been carried out developed countries, failing to capture the complex environments in which Low and Middle Income Countries (LMICs) function with their multitude of sources, and manifold higher exposure levels. To address this, the Centre for Chronic Disease Control, Public Health Foundation of India, and the Harvard TH Chan School of Public Health established a GEOHealth Hub to examine the links between ambient air pollution and cardiometabolic diseases and risk factors. The hub builds on the work of the CARRS cohort, functional since 2010, by carrying out retrospective associations to build the evidence base for AP & CVD risk factors and outcomes in LMICs. Simultaneously, to build the necessary capacity to carry out the proposed research aims of the hub, and to build a cadre of trained environmental health researchers and policymakers, the Hub is also carrying out a series of short, medium and long-term capacity building initiatives ranging from in-person intensive week-long training programs to Master's level training at HSPH. Till date, over 225 individuals have been trained across 50 institutions in India and neighboring countries. With strong linkages to the Indian health system and the engagement of multiple local partners, the Hub aims to characterize a key environmental threat affecting Indians, and drive policy to address this threat.

### **S03.03.12. Geohealth Hub: Improving Agricultural Health in Southeast Asia**

Pornpimol Kongtip

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Abstract: Forty percent of Thai people are engaged in agriculture. The CWEND GEOHealth Hub in Southeast Asia has focused on measuring occupational exposures and health impacts among agricultural workers. We have recruited farmers that use chemical pesticides and fertilizers and organic farmers to investigate whether they are significantly different in working conditions, musculoskeletal disorders, accidents, and a range of health problems, including metabolic disorders. In comparing the general health of organic and chemical use farmers, we found that the chemical use farmers had significantly higher BMI, waist circumference, body fat%, triglyceride, total cholesterol, LDL and blood pressure than the organic farmers. The organic farmers had significantly higher musculoskeletal disorders of the wrist/hands, fingers, upper back, hip and ankle/feet than the chemical farmers did. Chemical induced hearing loss was investigated among farmers exposed to both noise from agricultural machines and pesticides and compared to organic farmers exposed to only noise and to farmers with neither exposure. Audiometric testing of the high frequencies showed that as cumulative exposures to both noise and to pesticides increased, farmers had a significantly higher risk of hearing loss, suggesting an ototoxic effect of pesticides. Organophosphate pesticides (OP) and paraquat were measured in the meconium of newborn babies where we found 98.5% of samples had OP residues and 55% of the samples had paraquat residues. The incidence of kidney damage was investigated among sugarcane cutters using biomarker measurements (NGAL) pre and post shift. We found that NGAL significantly increased across the workshift, suggesting kidney damage may be occurring. Through the research training and mentoring component of the GEOHealth Hub, we are building capacity for occupational and environmental health research that will inform changes to policy and practice in agriculture in Southeast Asia.

### **S03.03.13. The Bangladesh Geohealth Hub: Household Air Pollution, Climate Change and Garment Industry Work**

Mohammad Yunus

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5. School of Kinesiology and Health Science, Faculty of Health, York University, Toronto, ON, Canada.
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Abstract: Household air pollution (HAP) is a global public health problem and less well-studied in developing countries. The overall goal of Bangladesh Hub is to conduct a population-based study (n=600) to examine effects of HAP on preclinical markers of cardiovascular diseases, lung function and immune dysfunction in rural Bangladesh. We will also evaluate impact of clean fuel use (LPG) on health outcomes and conduct two pilot studies to explore health hazards of garment industry work and climate change (temperature and mortality). For capacity development on environmental and occupational health research in Bangladesh, training courses are being conducted at University of Chicago and Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh. We have completed 24hr personal exposure (48hr for a subset) to particulate matter (PM<sub>2.5</sub>), carbon monoxide (CO) and black carbon (BC) on 231 participants using RTI MicroPEM and Lasker CO data logger. On average 48hr concentration of PM<sub>2.5</sub>, CO, BC was 124±108µg<sup>m</sup>-<sup>3</sup>, 1.2±0.9ppm and 4.7±2.1µg<sup>m</sup>-<sup>3</sup> respectively (n=100). Outcome assessments are in progress. Preliminary analysis showed mean carotid intima media thickness, reactive hyperemia index, EKG derived QTc (Bazett's) was 740.9µm, 1.65 and 435ms respectively. Post bronchodilator administered FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC was 2.1L, 2.6L and 80.8% respectively. We observed inverse relationship (not statistically significant) between PM<sub>2.5</sub>>100µg<sup>m</sup>-<sup>3</sup> and BC>3µg<sup>m</sup>-<sup>3</sup> with lung function parameters in adjusted models. Cell phenotyping (done by flow cytometry) in women with high PM<sub>2.5</sub> exposure (n=8, 191±70µg<sup>m</sup>-<sup>3</sup>) had lower percentage of T helper cells, higher Treg cells compared to women with low PM<sub>2.5</sub> exposure (n=8; 63±26µg<sup>m</sup>-<sup>3</sup>). An indication of imbalance in both cellular and humoral immunity in response to HAP was observed. Three Bangladeshi candidates attended short courses and three others are in one year post-doctoral training at University of Chicago. Several short courses were organized by BSMMU.

S03.03C. Milestones in Air Pollution Epidemiology: A Symposium in Honour of Dr. Richard T. Burnett

**S03.03.14. Milestones in Air Pollution Epidemiology: Introduction to a Symposium in Honour of Dr. Richard T. Burnett**

Aaron Cohen

*Aaron J. Cohen<sup>1</sup>, Daniel Krewski<sup>2</sup>*

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*2. McLaughlin Centre for Population Health Risk Assessment, University of Ottawa, Ottawa, ON, Canada.*

Abstract: Developments in epidemiologic and statistical methods over the past two decades have enabled quantification of adverse effects of long-term exposure to ambient air pollution, and expert opinion now considers these effects to be causal. Based on this evidence ambient air pollution has now been estimated to be among the leading risk factors for global mortality from non-communicable disease, providing a firm foundation for policy action by national governments and international organizations such as WHO and World Bank. For over 25 years Dr. Richard Burnett of Health Canada has been in the forefront of these developments, playing a leading role in advancing statistical methods for air pollution epidemiology and policy analysis. The symposium highlights milestones in air pollution research to which Dr. Burnett has contributed, summarizing past work, current status and prospects for further progress, and acknowledging the role that public funding of scientific research and support of scientists in government plays in advancing public health. Following a brief introduction by session organizers highlighting Dr. Burnett's contributions, leading air pollution epidemiologists and collaborators of Dr. Burnett discuss research that has advanced epidemiologic knowledge. In conclusion, Dr. Burnett will comment briefly on the future of air pollution epidemiology.

### **S03.03.15. Assessing Long-Term Health Effects of Air Pollution with Advanced Spatial Models**

Michael Jerrett

*Michael Jerrett<sup>1</sup>*

*1. Environmental Health Sciences, UCLA, Santa Monica, CA, United States.*

Abstract: Near the end of the last millennium, relatively few studies on the long-term health effects of air pollution had been undertaken. Two studies were effectively being used for setting government regulations designed to protect public health, namely the American Cancer Society Cancer (ACS) Cancer Prevention II Cohort Study and the Harvard 6-Cities Study. These studies came under increasing scrutiny due to their influential role in setting public health regulations in the United States and elsewhere. As a result, the U.S. Congress requested an independent reanalysis of these two studies. The Health Effects Institute administered the study, which was led by Drs. Krewski and Burnett. Working with fellow statistician Dr. Renjun Ma, Dr. Burnett developed a new flexible method of estimating the Cox proportional hazards model with allowance for random effects that essentially captured the residual variation not accounted for by the fixed predictors in the model. This allowed for the development of an iterative and powerful new method for investigating and minimizing confounding from our Cox model predictions because we could assess the size of the residual variation in total with the random effects variance, and we could also map out the random effects to search for spatial patterns that would represent potentially important missing confounders. This led to a 15-year endeavor to refine these models with the development of new random effects software that we used to assess the long-term effects of air pollution in the ACS cohort and subsequently several other cohorts. In this presentation, I will introduce the random effects method and show several examples that illustrate the capacity of this method to defend against residual confounding and to ultimately produce the sound science required to support regulatory standards and health impact assessments.

### **S03.03.16. Analyses of Air Pollution and Mortality in the American Cancer Society Cancer Prevention Study-II**

Michelle Turner

*Michelle C. Turner<sup>1</sup>*

*1. Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain.*

Abstract: Over the past two decades, the American Cancer Society Cancer Prevention Study-II (CPS-II) has provided valuable information regarding the mortality health effects of long-term exposure to ambient air pollution. The CPS-II is a large-scale prospective cohort study of nearly 1.2 million Americans followed since 1982. Associations of all-cause and cause-specific mortality have been examined in detail with increasing: length of follow-up time, numbers of included participants and observed deaths, and refinement of estimates of long-term exposure to ambient particulate and gaseous air pollutants and statistical modelling approaches over time. Ambient air pollution exposure estimates have ranged from those based on available central monitoring data aggregated at Metropolitan Area level through to more recent approaches based on remote sensing data, or geostatistical or hybrid models at much finer geographic units of scale. Source-related components of fine particulate matter (PM<sub>2.5</sub>) were also examined in other recent work. Epidemiological analyses have been extended to consider spatial autocorrelation and multiple levels of data within a random effects Cox model, interactions of PM<sub>2.5</sub> and cigarette smoking for both lung cancer and cardiovascular mortality, as well as evaluation of new mortality endpoints, including cancer mortality at 29 sites beyond the lung. Finally, the CPS-II has contributed important exposure-response data for application to disease burden assessments, including in both integrated risk functions, as well as in a new global exposure mortality model based only on cohort studies of ambient air pollution. This presentation will highlight key contributions of Dr. Burnett in independent re-analyses and extended analyses of the CPS-II and highlight major research findings with a focus on the most recent and ongoing work.

### **S03.03.17. Reflections on the Canadian CanCHEC Cohort: Where We've Been and Where We Are Going**

Paul Villeneuve

*Paul Villeneuve<sup>1</sup>, Toyib Olaniyan<sup>1</sup>, Daniel Crouse<sup>3</sup>, Scott Weichenthal<sup>2</sup>, Hwashin Shin<sup>4</sup>, Lauren Pinault<sup>5</sup>, Michael Tjepkema<sup>5</sup>*

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- 5. Statistics Canada, Ottawa, ON, Canada.*

**Abstract:** The Canadian Census Health and Environment Cohort (CanCHEC) was developed to advance the scientific knowledge about the impacts of prolonged exposure to low-levels of ambient air pollution. Initially, this large-scale cohort consisted of the 20% of Canadian households who were mandated to complete the more detailed long-form census in 1991. Dr. Burnett played a prominent role in the development of the cohort which has since been extended to include those who completed the long-form census in 1996, 2001, and 2006. Probabilistic record linkage of these cohorts were undertaken to link these individuals to Canadian income tax, mortality and cancer registry data. Linkages to the tax databases allowed for the determination of place of residence on an annual basis. Combined, these cohorts include nearly 13 million Canadians (37%) and approximately 1.7 million deaths identified during follow-up. Estimates of ambient air pollution concentrations have been assigned to cohort subjects based on their residential postal codes using a variety of methods including fixed-site monitoring, land use regression, and remote sensing techniques. Analyses of the CanCHEC have provided insights on how long term-exposure to low levels of ambient pollution is associated with cause-specific mortality. This presentation will highlight the contributions of Dr. Burnett with respect to the major research findings for air pollution that have been obtained from this cohort. These include estimates for associations between ambient air pollution concentration and mortality with respect to: (i) the shape of the exposure-response curve, (ii) oxidative burden of fine particulate matter, (iii) methods to indirectly adjust for the impacts of missing covariates, and (iv) methods to account for within- and between-city variations in risk. Lastly, this presentation will highlight ongoing and future research activities using the CanCHEC.

### **S03.03.18. Air Pollution Risk Functions and Estimates of Burden of Disease**

C. Arden Pope

*C. Arden Pope<sup>1</sup>*

*1. Brigham Young University, Provo, UT, United States.*

Abstract: Over the last 25 years there has been a growing literature providing evidence that long-term exposure to air pollution contributes to the risk of cardiopulmonary morbidity and mortality. Dr. Rick Burnett has made many important contributions to this literature, including primary roles in the various analyses of the American Cancer Society CPS-II cohort and the development of and analysis of the Canadian CanCHEC cohort. However, another remarkable contribution includes his development of well-defined and flexible risk functions for use in estimating the burden of disease attributable to long-term exposure to air pollution. This presentation will focus on Dr. Burnett's leadership and ongoing creative roles in developing well-defined and flexible risk functions, including functions that integrate information from studies of ambient air pollution, second hand cigarette smoke, and active smoking as well as meta-analytic approaches that use evidence from multiple studies from the growing literature.

S03.03D. The Benefit of Sharing Data for Unravelling the Complex Issue of Combined Exposures to Multiple Chemicals and their Effects to Humans and the Environment and In Support of Policies in EU and Globally

**S03.03.20. IPCHEM Serving EU and International Policies on Chemicals, Environment and Health: Policy Background and Objectives**

Stylianos Kephelopoulos

*Peter Korytar<sup>2</sup>, Frans Verstraete<sup>3</sup>, Maria Pilar Aguar Fernandez<sup>4</sup>, Sofie Norager<sup>4</sup>, Stylianos Kephelopoulos<sup>1</sup>*

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- 3. EUROPEAN COMMISSION, DG SANTE, Bruxelles, Belgium.*
- 4. EUROPEAN COMMISSION, DG RTD, Bruxelles, Belgium.*

Abstract: This presentation will provide the policy background and explain the objectives of IPChem as the European Commission's reference access point for searching, accessing and retrieving chemical occurrence data across various media (e.g. environment, humans, food/feed, indoor air and consumer products). It will outline how IPCHEM helps to fill the knowledge gap on chemical exposure and its burden on health and the environment, while streamlining the efforts to improve the way in which data, information and knowledge are gathered, managed, shared and preserved. IPCHEM operates via a continuously expanding strategic partnership that involves European Commission Services, EU Agencies, EU Member States and synergistic developments with important stakeholders on a global scale.

### **S03.03.21. The IPCHEM Platform: Main Tools and Functionalities, Data Integration Status, On-Going and Planned Activities, Impact and Recognition**

Stylios Kephelopoulos

*Silvia Dalla Costa<sup>1</sup>, Stylios Kephelopoulos<sup>1</sup>*

*1. EUROPEAN COMMISSION, JOINT RESEARCH CENTRE, ISPRA, Italy.*

Abstract: This presentation will outline the main tools and functionalities, the data integration status, the on-going and planned activities (including synergistic developments across the globe) and the so far received impact and recognition of the European Commission's Information Platform for Chemical Monitoring (IPCHEM). The focus will be on the IPCHEM's innovative principles and approaches for data management and visualisation which: (a) ease the task of accessing, retrieving, using and comparing chemical monitoring data in a coherent and efficient way; (b) enable a fast track and low cost system for interconnecting and harmonising on-the-fly remotely accessible data sources pertaining to different policy domains and scientific disciplines; (c) puts emphasis on data quality control rules which are embedded into the IPCHEM's engine and mechanism for boosting data standardisation and harmonisation.

### **S03.03.22. IPCHEM Supporting the Assessment of Chemical Mixtures**

Jacob Klaveren

*Jacob V. Klaveren<sup>1</sup>*

*1. RIVM, Bilthoven, Netherlands.*

Abstract: Humans and wildlife can be exposed to an infinite number of different combinations of chemicals in mixtures via food, feed, consumer products and the environment, which might impact their health. In order to adequately address combined exposures to multiple chemicals, a sound understanding of co-exposure scenarios is needed, which can be greatly enhanced by the use of monitoring data. The results of the workshop "IPCHEM supporting the assessment of Chemical Mixtures" will be presented, where European experts in the area of assessment of chemical mixtures gathered in December 2017 to discuss how IPCHEM can support the assessment of chemical mixtures in its current format and how it should further develop to facilitate co-exposure assessments even further.

### **S03.03.23. Experiences of the German Environment Agency in Sharing Data Via IPCHEM for Further Improving Human Health and Protecting the Environment**

André Conrad

*André Conrad<sup>1</sup>, Maria Rüther<sup>1</sup>, Gerlinde Knetsch<sup>1</sup>, Anette Küster<sup>1</sup>, Marike Kolossa-Gehring<sup>1</sup>*

*1. German Environment Agency (UBA), Dessau-Roßlau / Berlin, Germany.*

**Abstract:** The German Environment Agency (UBA) is Germany's federal agency for environmental protection. UBA collects various monitoring data to document the state of the environment and human exposure to pollutants, investigating associations, making projections, and giving policy advice. So far, UBA has contributed three data collections to IPCHEM: 1) Data of the German Environmental Specimen Bank (ESB) integrated in IPCHEM demonstrate the success of regulating chemicals like Hexachlorobenzene (HCB), as data show a substantial decrease of HCB in blood plasma. Moreover, the ESB documents pollutant levels in different environmental compartments. These data are a basis for further developing monitoring and regulatory activities. 2) Monitoring data from the POP-Dioxin database available via IPCHEM elucidate time trends concerning dioxins and furans as well as polychlorinated biphenyls (PCB) in Germany. This data yield new information on relevant sources and sinks of these compounds. 3) UBA's "database on pharmaceuticals in the environment" listed in IPCHEM was generated by a literature search of more than 1,000 publications. As one result, the analgesic Diclofenac was reported to be found in the environment of 50 countries, with some levels exceeding predicted no-effect concentrations (PNEC). Challenges of contributing data to IPCHEM are additional data transformation efforts and keeping data from ongoing monitoring programs up-to-date. An important opportunity related to IPCHEM participation is fully tapping the value of data for science and policy-making by putting them into a broader context and making them widely accessible. Increasing international visibility of own activities is another key benefit. Future UBA contributions to IPCHEM are i.a. indoor air quality data of the German Environmental Survey (GerES) and data from the HBM4EU initiative.

### **S03.03.24. IPCHEM as Reference Platform for the HBM4EU Project: Coordinating and Advancing Human Biomonitoring in Europe to Provide Evidence for Chemical Policy Making**

Catherine Ganzleben

*Catherine Ganzleben<sup>1</sup>, Greet Schoeters<sup>2</sup>, Marike Kolossa-Gehring<sup>3</sup>*

*1. European Environment Agency, Copenhagen, Denmark.*

*2. VITO, Antwerp, Belgium.*

*3. German Environment Agency, Berlin, Germany.*

Abstract: HBM4EU was launched in January 2017 to coordinate and advance human biomonitoring across 28 partner countries, in order to generate coherent and representative data in support of chemical policy-making in Europe. A key element of the work is the management of human biomonitoring data, including data transfer, access to data and respecting data protection legislation and ethics requirements. IPCHEM provides the tool for data management under HBM4EU. At the same time, HBM4EU identifies existing datasets and generates new data for inclusion in IPCHEM, enriching the platform. The presentation will highlight the synergies between these two EU initiatives, as well as describing the challenges encountered in the start-up phase of managing data under HBM4EU.

**S03.03.26. The U.S. EPA Activities and Information Systems Used for Chemical Exposure Screening, Modelling and Prioritisation and Risk-Based Decision Making: Needs, Challenges and Opportunities for Data Sharing and Interoperability of Tools on Global Scale Including**

Katherine Phillips

*Katherine Phillips<sup>1</sup>, Kristin Isaacs<sup>1</sup>, Kathie Dionisio<sup>1</sup>, John Wambaugh<sup>2</sup>, Antony Williams<sup>2</sup>*

*1. National Exposure Research Laboratory, US EPA, RTP, NC, United States.*

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Abstract: Within the US EPA Office of Research and Development's (ORD's) Chemicals for Safety and Sustainability (CSS) research program, efforts are underway to provide information that is useful for the risk-based prioritization of thousands of chemicals, particularly those found in consumer products. The information has been made publicly available through ORD's CompTox Chemistry Dashboard (<https://comptox.epa.gov>). In this presentation the research efforts that contribute to the collection and curation of consumer product formulations, article compositions and ingredient uses will be discussed. This information is obtained through both automated collection techniques from manufacturer-supplied documents and measurement of chemicals via suspect screening analysis. Finally, predictions from ORD-developed models for such values as physicochemical properties, functional use, product composition, and chemical exposure, which are provided via the Chemistry Dashboard, will be discussed. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the US Environmental Agency.

### **S03.03.27. Synthesizing Exposure Data for Regulatory Decision Making: The Need for a Centralized Data Warehouse**

Sandra Kuchta

*Sandra Kuchta*<sup>1</sup>

*1. Health Canada, Ottawa, ON, Canada.*

Abstract: The Chemicals Management Plan (CMP) is a Government of Canada initiative aimed at reducing the risk posed by chemicals to Canadians and their environment by assessing substances used in Canada and by taking action on chemicals found to be harmful. Many potential sources of exposure are considered, including but not limited to, environmental media, food, cosmetics, cleaning products, do-it-yourself products, and toys. Data used to estimate exposure to chemical substances come from a variety of sources and can vary widely. The speaker will highlight the need for the development of a global centralized data warehouse to store broad types of exposure data across international jurisdictions for both chemical risk assessment and priority setting. The presentation will include an analysis of exposure data used for the assessment of approximately 3000 chemical priority substances as part of Canada's CMP and will highlight the disparate sources of key chemical-specific exposure data including: monitoring data in air, soil or water; product concentration data; biomonitoring data; food concentration data; and chemical use volumes that are often considered for regulatory risk assessment. This presentation will also illustrate how a centralized data warehouse for exposure will help to increase efficiency of exposure assessment and will lead to increased data sharing and the filling of data gaps. This will be illustrated using examples from the CMP. The types of chemical-specific data that can be compiled and stored in this warehouse will be highlighted, such as environmental and effluent monitoring data, environmental release volumes, empirical phys-chem properties, empirical degradation half-lives, and results of empirical product testing, such as emission and migration rates. Lastly future activities such as advancements in assessing combined exposures as well as potential challenges of data standardization, data quality, and data confidentiality will be discussed.

## S03.03E. Transforming Air and Water Quality Research Into Concrete Actions

### **S03.03.28. The Role of Health-Based Air Quality Guidelines in Transforming Local Policy Actions**

Klea Katsouyanni

*Klea Katsouyanni*<sup>1</sup>

*1. Hygiene, Epidemiology and Medical Statistics, National and Kapodistrian University of Athens, Athens, Greece.*

Abstract: Legal standards for air pollutants concentrations are based on a number of considerations including the cost and the availability of technology for decreasing the levels, socio-economic factors and the effects on the environment and human health. Thus, non exceedance of the legal standards does not necessarily imply the absence of health effects. The World Health Organization provides evidence based air quality guidelines taking into account only the effects on human health. These are periodically revised and updated to reflect the current scientific knowledge. During the first decades they were oriented towards Europe but since 2005 they are global. Are these guidelines useful for policy making? Are they useful for increasing population awareness? Are they a useful tool for scientists seeking to translate their findings into meaningful messages for policy decisions? Reflections on twenty plus years of experience with the formulation of the WHO air quality guidelines will be presented. Issues and problems that came up and were resolved in a specific way will be looked upon critically and an effort to draw conclusions will be made. For example, the considerations which may lead to a change in the reference pollutants and what might be the consequences will be discussed, and, whether a threshold value is necessary even if there is limited evidence for one. Cases where the W.H.O. guidelines have been useful for scientists and policy makers in supporting the case for cleaner air as well as in raising awareness both in policy making bodies and in the general public will be presented.

### **S03.03.29. Shrinking Space, Expanding Time: Challenges in Applying Air Pollution Research Findings at the Local Level**

Ray Copes

*Ray Copes<sup>1</sup>*

*1. PHO/UofT, Toronto, ON, Canada.*

Abstract: . The link between episodes of poor air quality and adverse effects on health is well known to the media, public and policy makers at all levels. The last several decades of air pollution research have made clear the importance of long term exposure to air pollution as a risk factor for chronic diseases. More sophisticated exposure assessment methods have also revealed that gradients of air pollution within communities are important with respect to health risks. While this research has influenced national air quality standards, its incorporation into local decision making has proved more challenging. To some extent this may reflect a lack of familiarity with recent air pollution research on the part of policy makers at the local level. However, it may also reflect some of the inherent challenges in dealing with spatial versus temporal variation as a determinant of health risk.

### **S03.03.30. Lead in Drinking Water: The Slips Twixt Lip and Cup**

Ronnie Levin

*Ronnie Levin<sup>1</sup>*

*1. Environmental Health, Harvard School of Public Health, Boston, MA, United States.*

Abstract: The deleterious effects of lead have been known for centuries, and US EPA has methodically addressed the major sources of lead exposure. Nonetheless, media coverage of blatant violations of the US lead in drinking water rule repeatedly splay across newspapers throughout the country. Each time, regulators and administrators have expressed surprise and shock at the revelations. Each time, the public is assured by local, state and federal officials that processes are in place to remediate and safeguard health, now and in the future. Nonetheless, the evidence stands that EPA's current lead in drinking water standards are inadequate protections, and that strengthened information flow is required at each step of the process to protect the public.

### **S03.03.31. Environmental Public Health Tracking: From Data to Action**

Fuyuen Yip

*Fuyuen Yip<sup>1</sup>*

*1. US Centers for Disease Control and Prevention, Atlanta, GA, United States.*

Abstract: The National Environmental Public Health Tracking Program (Tracking Program) has worked closely with a community of funded state and local health departments to develop the National Environmental Public Health Tracking Network (Tracking Network), an integrated network of environmental health surveillance data-including air, water, and specific health outcome data-at the local, state, and national levels. Application of these data is key to support evidence-based decision-making and public health actions within state and local programs to help promote healthy and informed communities. The Tracking Program continues to enhance the infrastructure of the Tracking Network to support consistent use of its data and program resources to help inform public health actions, with the goal of reducing the burden of environmentally related health conditions. This presentation will highlight how the Tracking data and program resources have been used to inform air and water quality-related public health action at the state and local level.

### **S03.03.32. U.S. EPA Solutions for Energy, Air, Climate, Health (SEARCH) Center: Lessons Learned**

Michelle Bell

*Michelle Bell<sup>1</sup>*

*1. Yale University, New Haven, CT, United States.*

Abstract: While public health research is intended to provide societal benefits, challenges remain in translating science into action and in connecting the scientific community to stakeholders and decision makers. The Solutions for Energy, Air, Climate, and Health (SEARCH) Center is a 5-year interdisciplinary Center of connected research projects funded by the United States Environmental Protection Agency. The main objective of the Center is to investigate emerging energy transitions in the U.S. and the resulting air pollution and health outcomes through air quality modeling, economic modeling, air quality measurements, and epidemiological analysis to characterize factors contributing to emissions, air quality and health. In addition to the scientific research, the Center includes a Policy and Decision-Making Unit. This work is designed to incorporate regulators and policy makers into the scientific process from the earliest design and research stages, rather than only at the end when scientific results are communicated. This presentation will include lessons learned from this process to aid the scientific community's ability to provide decision makers with the most effect information on environmental health.

## O03.04A. Characterizing Long Term Trends in Air Pollution Using Stationary and Low Cost Monitoring

### O03.04.01. Assessment of Temporal and Spatial Trends of Air Pollutants Using Low-Cost Air Quality Sensors in Peñuelas, Puerto Rico

Stephen Reece

*Stephen Reece<sup>1</sup>, Ron Williams<sup>2</sup>, Maribel Colón<sup>2</sup>, Evelyn Huertas<sup>3</sup>, Marie O'Shea<sup>4</sup>, Patricia Sheridan<sup>4</sup>, David Southgate<sup>5</sup>, Gladys Portuondo<sup>5</sup>, Noel Suyas<sup>5</sup>, Barbara Wyrzykowska-Ceradini<sup>6</sup>*

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*5. Desarrollo Integral del Sur, Inc., Ponce, Puerto Rico, United States Minor Outlying Islands.*

*6. Jacobs Technology, Inc., Research Triangle Park, NC, United States.*

**Abstract:** The U.S. Environmental Protection Agency (EPA) is involved in the discovery, evaluation, and application of low-cost air quality sensors to support citizen scientists by directly engaging with them in the pursuit of community-based interests. The recent advancement of low-cost (<\$2,500) air quality sensors has allowed a wide range of stakeholders, including communities, tribes, and industry, to deploy low-cost sensors in a range of applications to better understand local air quality conditions and to supplement regulatory monitoring locations. The low-cost advantage of these sensors enables a network of multiple sensors to be deployed to assess temporal and spatial trends in micro-environments at high-time resolution. Here we present results from the deployment of the EPA developed Citizen Science Air Monitor (CSAM) used to conduct approximately five months (October 2016 - February 2017) of intensive air quality monitoring in an area of Puerto Rico (Tallaboa-Encarnación, Peñuelas) with little historical data on pollutant spatial variability. The CSAMs were constructed by combining various low-cost original equipment manufacturer (OEM) sensors and system integration technologies into a single unit to maximize ease of operation, while meeting a specific research requirement. The CSAMs were distributed across eight locations to collect real-time measurements of the particulate matter size fraction 2.5 micron (PM<sub>2.5</sub>), total volatile organic compounds (tVOCs), and nitrogen dioxide (NO<sub>2</sub>). In addition to the CSAMs, meteorological parameters (wind speed, wind directions, temperature, relative humidity) were obtained from four collocated weather stations. Initial analysis of 24-hour averaged pollutant measurements showed concentrations did not exceed 12.0 µg/m<sup>3</sup>, 60.0 ppb, and 40.0 ppb for PM<sub>2.5</sub>, tVOCs, and NO<sub>2</sub>, respectively. These results highlight the added value provided by low-cost sensors to supplement regulatory monitors despite their known limitations.

### **O03.04.02. Ambient Ultra-Fine Particle Exposure Assessment Based on Mobile and Stationary Monitoring during Fine Dust Season in Stuttgart, Germany**

Tobias Schripp

*Tobias Schripp<sup>1</sup>, Maximilian Braun<sup>1</sup>, Tobias Grein<sup>1</sup>, Patrick Oßwald<sup>1</sup>*

*1. Chemical Analysis, Institute of Combustion Technology (DLR), Stuttgart, Germany.*

Abstract: The air quality in the city of Stuttgart is a topic of high relevance in public media due to the frequent exceedance of guideline values and the resulting discussion on possible diesel car bans. The city features stationary monitoring stations for air quality in the most relevant areas of the city. These stations are expanded by a large sensor network operated by private individuals. Even though the available data on ambient air pollutants is rather comprehensive, the source appointment and mitigation strategies are discussed controversially. In this study, a stationary measuring station was operated for approx. 1 month during "fine dust season" (from October to April) with a series of different particle counters (SMPS, OPS). In addition, mobile measurements by car were performed in downtown Stuttgart and nearby. The car was equipped with an Engine Exhaust Particle Sizer, an Optical Particle Sizer and a Black Carbon Monitor. For a better source appointment, a CLD64 was continuously monitoring the concentration of nitrogen oxides (NO<sub>x</sub>). The stationary particle counter station recorded significantly lower concentrations than the official monitoring station (at a street with heavy traffic) - even though the distance was approx. 500 m. This indicates that the heavily polluted areas have a low extension and are clearly outlined. The mobile measurements support that the official monitoring station is located at the worst air quality position. The particle exposure varies significantly in the area. Based on the lung deposition model of the ICRP, the main fraction of particle mass is deposited in the upper respiratory pathways. However, the particle counter revealed elevated concentrations of particles < 100 nm which are usually not covered by gravimetric analysis. This indicates that particle counters and sensors might be a substantial supplement to regular monitoring stations to assess the real exposure of city dwellers.

### 003.04.03. Source and Potential Health Risk of Trace Metals in the Urban Atmosphere

Chien-Cheng Jung

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**Abstract:** The objective of this study was to assess the seasonal variations and health risks of trace metal levels and investigate whether Pb isotope ratios can be used as an indicator of the source for trace metals. A BGI PQ200 Fine Particulate Sampler was used to collect PM<sub>2.5</sub> on Teflon filters during the summer of 2015 and spring of 2016 in Taipei, Taiwan. The inductively coupled plasma mass spectrophotometer (ICP-MS) and multi-collector ICP-MS were used to analyze the trace metals (As, Cu, Cd, Cr, Mn, Pb, and Zn) and Pb isotopes (<sup>206</sup>Pb, <sup>207</sup>Pb, and <sup>208</sup>Pb), respectively. This study also calculated the potential health risk for trace metals in both summer and spring for different populations. Our data showed that the levels of trace metals were significantly higher in spring than in summer. There were higher non-carcinogenic and carcinogenic risks in spring than in summer through inhalation exposure. All hazard index values were below a safe level (1.0), but the values were higher for children than adults. The lifetime cancer risk values for Cr (VI) exceeded an acceptable level (1E-6) in both spring and summer and the value of As also exceeded the acceptable level in spring. Moreover, the Pb isotope ratios (<sup>206</sup>Pb/<sup>207</sup>Pb and <sup>208</sup>Pb/<sup>207</sup>Pb) were associated with the levels of all trace metals. The results from Pb isotope ratios and backward trajectories model indicated that long-range transport from China was an important contributor of trace metals during the episodes in spring, local emission was a major source in summer. This study suggests that it is necessary to reduce the emissions of trace metals due to higher health risk in Taipei. Pb isotope ratios can be used as an indicator of source for trace metals.

#### **003.04.04. Ozone Chemistry over the Syrian Arab Republic: Impact of the War**

Lyazzat Kulmukanova

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Abstract: Ground ozone (O<sub>3</sub>) is a major photochemical air pollutant that has negative effects on both human health and environment, exposure to which results in the development of respiratory diseases and damage to ecosystems. Ozone does not have direct natural or anthropogenic sources of emission and its formation is accounted for the cyclic photochemical reaction between its precursors, nitrogen dioxide (NO<sub>2</sub>) and volatile organic compounds (VOC). This study investigated ozone concentration and chemistry over Syrian cities Deir ez-Zor and Aleppo between 2005 and 2016. These two cities experienced a civil war in 2011 that later on involved other countries. To identify how the trends of NO<sub>2</sub> and VOC were changed due to the war, and subsequently their effect on the ozone formation, the study was divided into two periods, before and after the war. This study was conducted by analyzing Formaldehyde-to-Nitrogen Dioxide ratio (FNR), which is considered to be the main indicator of ozone sensitivity regime. It was observed that starting the war, Aleppo, located on the west of Syria experienced a change of FNR values from the range of 0-1 to 1-2 which represents a shift in ozone sensitivity regime. The city located on the east of the country, Deir ez-Zor, did not experience a considerable change in the regime, as FNR values were maintained above 2 throughout the given period. Such different responses to the presence of the war in the cities of the same country could emphasize that the war has variant effects on the ozone chemistry over the cities due to the intensity of the war interactions and background of the cities. Lastly, it was found that changes in ozone chemistry in Syria due to the war resulted in the similar changes in ozone chemistry in the bordering countries (Turkey and Lebanon), and thus areas of these countries which are close to the borders of Syrian Arab Republic experienced ozone peaks in 2012 and 2016 due to the sharp increases of ozone in Syria itself.

### **003.04.05. Spatial Distribution of Particulate Matter in Winter Nights in Temuco, Chile: A Study of Residential Wood-Burning Impacts Using Mobile Sampling**

Pablo Ruiz-Rudolph

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**Abstract:** Temuco is a city heavily impacted by residential wood-burning, which causes strong episodes of air pollution, particularly in winter. Little is known about the spatial distribution of wood-burning pollutants, and knowing this distribution is key to develop spatial models to be used in study of chronic health effects. The objective of this study is to characterize spatially the distribution of particulate matter in Winter nights in Temuco using measurements. For 20 nights (8pm to 2am) of winter 2016, continuous monitors for particulate matter <2.5  $\mu\text{m}$  (PM<sub>2.5</sub>) and ultrafine particles (UFP) were deployed in a vehicle along with a positioning system. Assigned routes crossing the city and scanning the boroughs were performed using a pair of samplers, while another pair were kept at central site for normalization. Measurements were collapsed by hour and day in spatial grids of 50, 100, 200 y 500 meters side using the mean, standard deviation and the ratio to the central site for each grid cell. Then, pollutant distribution was visually inspected and analyzed using measures of dispersion and heterogeneity. PM<sub>2.5</sub> concentrations were in a range similar those observed at the central site (~50-100  $\mu\text{g m}^{-3}$ ) but with a large spatial variability, with gradients that diminished towards the outskirts of the city. UFP concentrations were in the order of a polluted city (~50.000-100.000 counts  $\text{cm}^{-3}$ ), with the central site being a poor predictor of mobile measurements. Heterogeneity indicators were high for both pollutants, indicating a high spatial variation for both pollutants. In general, it was observed a pattern of increasing PM<sub>2.5</sub> toward residential areas and increasing UFP near highways. In conclusion, mobile sampling seems a useful alternative to study spatial distribution of pollutants in these settings. Produced data can be used to develop spatial models such as Land-Use Regression (LUR models).

## O03.04B. Health Outcomes Associated with Perinatal Exposure to Air Pollution

### O03.04.06. Prenatal Exposure to PM2.5 and Infant Autonomic Nervous System Reactivity: Effect Modification by Sex and Maternal Total Antioxidant Intake during Pregnancy

Whitney Cowell

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**Abstract:** The autonomic nervous system (ANS) plays a key role in stress reactivity and is programmed during gestation. We investigated associations between prenatal exposure to fine particulate matter (PM2.5) and infant ANS reactivity during a stress challenge among 239 maternal-infant pairs enrolled in a Boston-based birth cohort. We estimated daily residential PM2.5 using satellite data in combination with land-use regression predictors. At 6 months, we measured parasympathetic nervous system (PNS) activity using continuous ECG and respiration monitoring during the repeated Still Face Paradigm (SFP-R), which is designed to elicit infant stress reactivity and regulation in response to maternal disengagement and interaction. We used multivariable linear regression to examine average PM2.5 exposure across pregnancy in relation to PNS withdrawal and activation, indexed by changes in respiratory sinus arrhythmia (RSA). We grouped infants by 'typical' or 'atypical' patterns of RSA change and used multivariable logistic regression to model associations between PM2.5 and group assignment. We examined interactions with sex and maternal total antioxidant intake during pregnancy, estimated using a food frequency questionnaire. We detected significant 3-way interactions ( $p < 0.01$  across models) between PM2.5, sex, and antioxidants. Among girls with low prenatal antioxidants (<50th percentile), each 10-unit increase in PM2.5 was associated with marginally reduced PNS withdrawal during stress (25% increase in RSA,  $p = 0.06$ ), marginally depressed PNS activation during recovery (24% decrease in RSA,  $p = 0.05$ ), and significantly increased odds of an 'atypical' response pattern (OR: 2.7, 95% CI: 1.2, 5.9). We did not observe significant findings among girls with higher prenatal antioxidants or among boys. Prenatal exposure to PM2.5 may disrupt programming of autonomic stress-response systems among girls. Higher intake of antioxidant-rich foods during pregnancy may protect against these effects.

### **003.04.07. Prenatal Air Pollution and Childhood Allergic Diseases: The Potential Modifying Effect of Adherence to Mediterranean Diet**

Leda Chatzi

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**Abstract:** Background: Prenatal exposure to air pollution has been associated with increased risk of childhood asthma and allergies, however, less is known regarding the potential modifying effect of maternal diet during pregnancy in this association. Objectives: To investigate whether prenatal exposure to particulate matter (PM) is associated with childhood eczema, allergic rhinitis (AR) and asthma, and to assess a potential modifying effect by maternal adherence to Mediterranean Diet (MD) using data from the Rhea pregnancy cohort. Methods: Allergic outcomes were evaluated in children at ages 4 (n=809) and 6 (n=567) years old using validated questionnaires. Land-use regression models and back-extrapolation procedures were utilized to estimate outdoor levels of PM<sub>2.5</sub>, PM<sub>10</sub>, and PM<sub>coarse</sub> at home addresses during pregnancy. MD was assessed by a validated food frequency questionnaire, and MD adherence was evaluated using an a priori score. Multivariate logistic regression models were used and interaction terms with MD were added in the model to evaluate any PM by MD effect modification. Results: Overall, prenatal PM exposure was significantly associated with an increased risk of AR and eczema at ages 4 and 6 but not with asthma. Stratified analysis by MD adherence indicated that PM<sub>2.5</sub> exposure was associated with an increased risk of AR and eczema at age 4 (OR, 95%CI: 2.74, 1.47-5.12 and 2.01, 1.02-3.93, respectively) in children of mothers with low MD adherence, whereas this effect was not apparent in children of mothers with high MD adherence (Pinteraction 0.027 and 0.017, respectively). Similarly, PM<sub>coarse</sub> exposure was associated with an increased risk of eczema at both 4 and 6 years old (Pinteraction 0.015 and 0.043, respectively), and PM<sub>10</sub> with eczema at 6 years old only in children of mothers with low MD adherence (Pinteraction 0.033). Conclusion: Maternal adherence to MD may modify the detrimental effect of prenatal air pollution on childhood allergy.

### **O03.04.08. The Associations between Exposure to Fine Particulate Matters during Pregnancy and Early Postnatal Period and Asthma Onset in a Metropolitan Area in Taiwan**

Chau-Ren Jung

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**Abstract:** Background/Aim The development of lung is a multi-stage process from conception to early postnatal period, any disruption of the process by pollutants may trigger respiratory morbidity later. Exposure to particulate matters (PM) during both prenatal and postnatal periods may be associated with the increased risk of asthma. We aimed to evaluate the effects of weekly average PM with aerodynamic diameter less than 2.5 $\mu$ m (PM<sub>2.5</sub>) during prenatal and early postnatal periods on asthma and tried to find out the most vulnerable time windows of asthma that would help to elucidate the possible mechanism for effects of PM<sub>2.5</sub> on asthma. Methods A birth cohort study including 184,604 neonates born during 2004-2011 in Taichung city was retrieved from Taiwan Maternal and Child Health Database and followed up until 2014. A highly temporal resolution satellite-based hybrid model has been applied to estimate daily PM<sub>2.5</sub> for each subject. A Cox proportional hazard model combined with the distributed lag non-linear model was performed to evaluate the associations of asthma with weekly average exposure to PM<sub>2.5</sub> during prenatal and early postnatal period. Results Within the birth cohort, there were total 34,336 asthma cases (18.60%), the mean age of infants who received asthma diagnosis was 3.39 $\pm$ 1.78 years. The results reveal that increased exposure to PM<sub>2.5</sub> during 3-6 gestational weeks, 25-36 gestational weeks and during 10-50 weeks after birth were significantly associated with increased incident asthma. Additionally, we observed consistent positive associations of asthma with exposure to PM<sub>2.5</sub> during the prenatal and postnatal period for both males and females. Conclusion Our findings added evidence into the growing literature that both prenatal and postnatal exposures to PM<sub>2.5</sub> are associated with the later development of asthma. The vulnerable time windows may be within early and late gestation that showed a bimodal pattern. Further studies are needed to confirm the vulnerable time windows.

### **003.04.09. CC16 Levels into Adult Life Are Associated with Nitrogen Dioxide Exposure at Birth**

Paloma Beamer

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**Abstract:** Children's lung function and growth is adversely associated with exposure to nitrogen dioxide (NO<sub>2</sub>). Lower levels of circulating club cell secretory protein (CC16) in childhood are also associated with subsequent decreased lung function in adolescence and adulthood. Evidence from in vitro and in vivo studies suggests that NO<sub>2</sub> exposure may induce epithelial damage in the lungs and altered club cell proliferation and morphology. Our objective was to determine if increased ambient NO<sub>2</sub> levels at participants' home addresses at birth or age 6 were associated with decreased levels of CC16 from age 6-32 years. Participants were enrolled at birth in the Tucson Children's Respiratory Study and had circulating CC16 measured at least once between age 6-32 years. Annual average estimates of NO<sub>2</sub> were obtained for the address and year corresponding to each participant's home address at birth and at age 6. Linear mixed models were used to determine the association between exposure to NO<sub>2</sub> at birth or age 6 with CC16 levels from age 6-32 years. NO<sub>2</sub> exposures at birth or age 6 were available for 777 children with at least one CC16 measurement from ages 6-32. An interquartile range increase in NO<sub>2</sub> at the children's birth address was associated with a 4.89% (95% CI -9.04, -0.75) decrease in CC16 levels from age 6-32 years. An interquartile range increase in NO<sub>2</sub> at the children's age 6 address was not associated with a decrease in CC16 levels from age 6-32 years (-2.54%, 95% CI -7.03, 1.94). Similar results were obtained after adjusting for potential confounders including maternal smoking (NO<sub>2</sub> at birth -4.83% [95% CI -9.00, -0.66]; NO<sub>2</sub> at age 6 [-1.95%, 95% CI -6.47, 2.56]). Higher exposure to NO<sub>2</sub> at birth is associated with persistently low levels of CC16 from 6-32 years. We speculate that persistently low levels of CC16 may reflect airway injury induced by exposure to NO<sub>2</sub> during critical periods of lung growth, thus predisposing for diminished lung function later in life.

## O03.04C. Multiple Exposures and Development

### O03.04.11. Understanding the Time-Varying Association between Prenatal Metal Exposure Mixtures and Neurodevelopment

Yuri Levin-Schwartz

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**Abstract:** Humans are exposed to chemical mixtures at each life stage and their effects can vary over time (i.e. critical windows). We extended weighted quantile sum (WQS) regression, a method designed to assess correlated exposures at a single time point, to estimate the effect of metal mixtures on neurobehavior over multiple time points, their critical windows and the contributions of each mixture component. We assessed neural function using the Rapid Visual Processing (RVP) task from the Cambridge Neuropsychological Test Automated Battery, focusing on latency to correct response and probability of correct response (POCR), in the Programming Research in Obesity, Growth, Environment and Social Stressors cohort in Mexico City. RVP data were gathered from 326 children aged 6-8 years and prenatal metal exposure was quantified using maternal blood at the 2nd and 3rd trimesters. Arsenic (As), cadmium (Cd), cesium (Cs), chromium (Cr), lead (Pb) and antimony (Sb) were selected based on their toxicological profile. Results are adjusted for age, gender, socio-economic status, maternal education and maternal age. In the overall model, the mixture was associated with latency [0.09; 95% CI[0.01, 0.17],  $p < 0.04$ ], driven largely by both 2nd and 3rd trimester Cs (combined weight=54.11%) and Cd (combined weight=20.53%). For POCR, the results were more variable by exposure timing. The overall mixture effect was -0.07 (95% CI[-0.15, 0.01],  $p < 0.08$ ), primarily driven by 3rd trimester Sb (weight=16.6%), Cs (weight=14.1%) and Pb (weight=13.2%), while 2nd trimester Cr contributed 16.7% of the weight. Overall, 3rd trimester metals contributed 58% of the weight and 2nd trimester metals contributed 42%. These results indicate that metal mixtures have unique critical windows and that WQS can be used to assess mixture effects, the contributions of each component, as well as discern time-dependent effects.

### **O03.04.12. Prenatal Exposure to Metals Mixtures and Neurobehavioral Outcomes at Age 7 from the Project Viva Birth Cohort**

Victoria Fruh

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**Abstract:** Background: Lead (Pb), manganese (Mn), and methylmercury are known neurotoxic metals and often co-exist in the environment. Less is known about their interactive and joint effects on specific childhood neurobehavioral domains, particularly for prenatal exposure. Aims: To evaluate the joint effects of prenatal exposure to multiple metals on mid-childhood neurobehavior. Methods: We measured Pb, Mn, selenium (Se) and mercury (Hg) concentrations in maternal 2nd trimester erythrocytes from 252 mother-child Project Viva participants in Massachusetts, USA. Parents and teachers rated child behaviors with the Behavior Rating Inventory of Executive Function (BRIEF) during mid-childhood (median 7.7 years). We evaluated joint effects of the metal mixture on neurobehavior using Bayesian Kernel Machine Regression, adjusting for maternal, paternal and child characteristics. Results: Median erythrocyte Pb, Mn, Se, and Hg concentrations were 11 µg/L, 33 µg/L, 205.7 µg/L, 3.6 x 10<sup>-3</sup> µg/L, respectively. We observed worse scores on parent- and teacher-rated scales with simultaneously increasing metal concentrations, suggestive of a joint effect, although not statistically significant. Se was a major contributor to associations for the Global Executive Composite and subscales. With other metals at their median, an IQR increase in ln-Se was associated with a 1.3 point increase (95% CI=0.02, 2.6) on the parent-rated organization of materials (OM) subscale indicating worse executive function. Increasing ln-Pb was also associated with worse OM (parent-rated: 0.7 (-0.6, 1.9)) and working memory (parent-rated: 0.9 (-0.5, 2.3)) subscale performance. There was no evidence of interaction. Conclusion: Our findings suggest that prenatal exposure to common metal mixtures may adversely affect executive function in childhood. In our study, Se was a key contributor to the associations, highlighting the importance of evaluating health effects of multiple metals including essential elements.

### **003.04.13. Assessing the Relation of Chemical and Non-Chemical Stressors with Risk-Taking Behavior among Adolescents Living near the New Bedford Harbor Superfund Site**

Veronica Vieira

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**Abstract:** Background: Adolescent risk-taking is multifactorial and influenced by sociodemographics and peer behavior. In addition, evidence suggests that early life exposure to neurotoxicants such as polychlorinated biphenyls (PCBs) and lead (Pb) can impede development of the prefrontal cortex and may contribute to risk-taking. This is of concern among communities that have been exposed to multiple chemical and non-chemical stressors. Methods: We investigated the relation of mixtures of prenatal chemical exposures and non-chemical stressors with adolescent self-reported sensation seeking and anger control in the New Bedford Cohort, a study of children born 1993-1998 near the New Bedford Harbor Superfund site. Outcomes were measured using the Behavior Assessment System for Children, 2nd ed., a standardized behavioral rating scale (n=476). We constructed multi-dimensional smooths using generalized additive models (GAMs) to explore relationships among combinations of stressors, with further adjustment for child's age at exam, sex, maternal education and marital status. Results: Cord blood Pb and PCB measures, maternal IQ and age at birth were included in GAMs. Children of younger mothers with lower IQ who were also exposed prenatally to higher Pb and PCBs had poorer anger control ( $p < 0.001$ ). This Pb/PCB pattern was not apparent for children of older mothers with higher IQs. Sensation seeking behavior was also associated with a mixture of Pb, PCBs, and maternal IQ ( $p = 0.041$ ), but with no differences by maternal age. Conclusion: Analyses suggest that prenatal chemical exposures and maternal characteristics may interact to contribute to increased risk-taking behaviors in adolescence. This work also illustrates the utility of GAMs for visualizing mixtures and non-linear relationships among risk factors, as the importance of both chemical and non-chemical stressors would not likely have been discovered using more traditional epidemiologic models. Funding: NIH/NIEHS P42ES007381; R01ES014864

### **O03.04.14. Using Tree-Based Analytic Methods to Investigate Associations of Multiple Exposures with Pubertal Development in Urban Girls**

Jeanette Stingone

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Abstract: Most research on childhood environmental contributors to early puberty has examined toxins singly in a limited window, often using parametric, regression-based modeling. A realistic assessment of health effects must incorporate multiple exposures over a longer period and allow for interaction between factors. Tree-based analytic methods recursively split the complete study population into multiple subsets based on exposure(s) that most strongly predict the outcome. Tracing down the branches created by these exposure-based splits yields exposure combinations associated with the outcome of interest, allowing for the simultaneous consideration of multiple exposures while allowing for modification by demographics and/or interaction between exposures. The goal of this analysis was to apply tree-based methods to data from a study of 192 nine-year-old New York City girls to identify exposures associated with pubertal development. Using data and biological samples collected during in-person interviews, we derived over 50 exposure variables including environmental biomarkers, ambient air pollutants, dietary components, and demographics. Pediatrician-assessed pubertal development was based on Tanner staging and recorded separately for breast and pubic hair, with stages 2 through 5 indicating puberty. We constructed multiple classification trees for pubertal outcomes utilizing all of the available environmental exposure metrics. For breast development, branches of the trees identified race-specific protective effects of five urine- or dietary-based measures of phytoestrogens. For example, breast development was less likely among Black girls with higher urinary concentrations of daidzein and among white/Latina girls with higher levels of urinary concentrations of genistein. These results illustrate how data-driven approaches can uncover environmental contributors to disease that may be masked when interactions or modification by demographics are not explicitly considered.

### **003.04.15. Multi-Metal Exposure and Children's Cognitive Development in Montevideo, Uruguay**

Julia Ravenscroft

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**Abstract:** There is growing evidence that co-exposure to multiple metals can result in increased neurotoxicity compared to single metal exposures. As co-exposure to multiple metals at fairly low levels is a likely scenario for most children, understanding the effects of metal mixtures on neurodevelopment is important. In a cross sectional study we examined the association between a metal mixture comprised of urinary concentrations of lead (Pb), arsenic (As), molybdenum (Mo), as well as hair concentrations of cadmium (Cd) and Manganese (Mn) with a measure of overall cognitive ability, the Woodcock-Muñoz General Intellectual Ability score (WMGIA,  $M \pm SD$ :  $473.7 \pm 11.8$ ). First-grade children (aged 6-8 yrs) from 11 private elementary schools within the city of Montevideo, Uruguay participated between July 2009 and August 2013. Metal concentrations were measured in first void urine samples via inductively coupled plasma mass spectrometry (ICP-MS). Metal concentrations were adjusted for specific gravity to compensate for variation in urine dilution, then log<sub>2</sub>-transformed. Rinsed, dried, and acid-digested hair samples were analyzed using ICP-MS and also log<sub>2</sub>-transformed. A weighted quantile sum regression (WQSR) approach was used in a complete case analysis ( $n=264$ ) to calculate a multi-metal index across 100 bootstrapped samples in a training data set (40% of observations). The association of the index with WMGIA was then tested (covariate-adjusted) in the validation set (60% of observations). Each 25% increase in the multi-metal index was associated with a 3.37 reduction in WMGIA score (0.8 % change from mean), indicating a modest but significant mixture effect. Each metal contributed differentially to the index, with Cd (42% overall) and Mo (25% overall) dominating. Understanding the effects of metal mixtures is critical for progressing the field of environmental health and protecting children's neurodevelopment. WQSR provides information that supplements single-metal models.

## O03.04D. Social and Environmental Determinants and Health 2

### **O03.04.16. Neighborhood Disadvantage and Self-Reported Health**

Timothy Wade

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**Abstract:** Self-reported health is a strong predictor of mortality. Residence in a disadvantaged neighborhood can adversely affect conditions such as safety, access to the natural environment, quality of housing, and stress which also influence health. We evaluated the association between self-reported health and neighborhood in a cross-sectional study in central North Carolina. Participants completed a clinic visit and a questionnaire. The questionnaire addressed self-reported health (Excellent, Good, Fair and Poor), medical history and demographics. Participants provided saliva and serum samples to test for a set of health biomarkers. Neighborhood information was obtained from the US Census for the census-block group associated with each participant's residence. A neighborhood disadvantage index (NDI) was created based on: % without high school degree, % unemployed, % below poverty, % vacant properties, % residences with > 1.5 occupants per room, and % on food assistance. Z-scores were calculated for each of the log-transformed characteristics, summed and categorized in quartiles (1=least disadvantaged; 4=most disadvantaged). Ordinal logistic regression was used to model self-reported health in relation to NDI. Individual measures of age, race, body-mass index, smoking, alcohol, and education were considered as covariates with final models selected by minimizing the AIC. There were 223 participants from 143 block-groups. There was a consistent trend across NDI quartiles with increasing disadvantage associated with worse self-reported health (aOR=1.28, 95% CI =1.02-1.63). Those in the highest NDI (most disadvantaged) were over 2 times (aOR=2.15, 95% CI=1.03-4.56) more likely to report worse health as those with the lowest NDI. These findings provide additional support for the important contextual effect of neighborhood on health. In future analysis, we will evaluate biomarkers which may mediate this association. This abstract does not represent EPA policy.

### **003.04.17. Use of Geocoding to Understand Variation in Neighborhood Socioeconomic Status in a Nationwide Occupational Cohort across Time, Space and Demographic Characteristics**

Gabriela Bustamante Callejas

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Abstract: Geocoding has been used in environmental epidemiology to understand geographically patterned exposures but has not been widely applied in occupational studies. We present the feasibility of geocoding a nationwide occupational cohort, the US Radiologic Technologists Study (USRT, N=146,021) to: (1) evaluate geocoding across time, (2) test precision of geocoding by rural (vs. urban) status and by neighborhood socioeconomic status (nSES), and (3) explore nSES distribution by some cohort demographic factors. We created a standardized nSES index, based on validated methods, for each census block-group in the US, at 3 time points, using 6 items from the U.S. Census (1990, 2000) and American Community Survey (2010): regionally-adjusted median household income and median housing value, % households with interest/income, % adults who completed high school, % adults who completed college, and % employed persons in managerial occupations. To link nSES to the cohort, we geocoded respondent addresses in 1992, 2003, 2010, to block-group of residence. Over 99% of addresses were geocoded; 76 to 86% were mapped to an address-specific block-group, while the rest were geocoded to a block-group of the zipcode centroid. Urban (vs. rural) addresses and those in the highest (vs. lowest) nSES quintile were more likely to be geocoded to an address-specific block-group (OR=4.6; 95%CI=4.5-4.7 and OR=6.4; 95%CI=6.1-6.7, respectively for 1992 addresses). Results of linear regression show higher nSES in 1990 was associated with USRT participants of female gender ( $\beta=0.22$ ; 95%CI=0.20, 0.23), older age ( $\beta=0.003$ ; 95%CI=0.002, 0.003), white race ( $\beta=0.37$ ; 95%CI=0.35, 0.38) and more recent age-adjusted certification year ( $\beta= -0.018$ ; 95%CI= -0.016, -0.019). Similar results were obtained for other years. This analysis indicates geocoding can describe neighborhood characteristics within the USRT which may be related to diseases linked to occupational exposures like cancer and cardiovascular disease.

### **003.04.18. Combined Prenatal Environmental and Social Exposures and Associations with Weight and Adiposity at Birth in the Denver Healthy Start Birth Cohort**

Sheena Martenies

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**Abstract:** Background Neighborhood environmental and social exposures are known risk factors for adverse childhood health outcomes, but the effects of combined exposures in these domains are not fully understood, particularly for body mass or adiposity at birth. We assessed single- and multi-domain exposures for participants in the Healthy Start study, a longitudinal cohort of 1410 mother-child pairs in Metropolitan Denver, CO, and tested associations with body measures at birth. Methods Environmental (ENV) exposures including ambient air quality, toxic release data, and built environment characteristics, e.g., impervious surface %; social (SOC) exposures including demographics, population vulnerability, and crime; and combined exposures (CE) averaged over a 5-year period were assessed at census tracts using a weighted index (scaled from 0-100) following CalEnviroScreen 3.0 and assigned using address at enrollment. Offspring body mass, fat mass, and fat mass percent (adiposity) were obtained by air displacement plethysmography within three days of birth. In separate linear regression models we tested associations between body mass or adiposity outcomes with ENV, SOC or CE as the main predictors. Results Exposure and outcome data were available for 993 (74%) participants. Median (range) ENV, SOC and CE values were 65.8 (53.9-82.5), 62.1 (7.3-98.2), and 48.9 (5.5-88.7), respectively. No significant associations were found with adiposity. A 10-point increase in SOC and CE was associated with a 22g (95%CI: 8-35g) and 24g (95%CI: 8-40g) decrease in body mass at birth, respectively. After controlling for maternal and infant covariates, associations for SOC and CE were attenuated and no longer significant at  $\alpha=0.05$ . Conclusions Combined exposures during pregnancy may be associated with lower body mass at birth. Future research will explore components of the indices and whether cumulative exposures or exposures during specific gestational periods are associated with offspring mass outcomes.

### 003.04.19. Social Determinants of Systemic Inflammation over the Life Course: A Multi-Cohort Study

Raphaële Castagné

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**Abstract:** This study explores the relationship between socioeconomic position (SEP) across the life course and circulating C-reactive protein (CRP), a marker of systemic inflammation, in 6 European cohort studies participating in the Lifepath project. To evaluate the importance of the context and cohort specificities, analyses were performed separately for each cohort and combined in a random effect meta-analysis of up to 23 008 participants (55.7% of men). First, we estimated the association between measures of three time point SEP (father's occupation as early life SEP, educational attainment as young adulthood, participant's last occupation as adulthood) and adulthood CRP, adjusting for health behaviours (smoking, alcohol consumption, sedentary) and body mass index (BMI). Second, to mimic life course experiences, we analysed the relationship between father's occupation and CRP, sequentially adjusting for subsequent measures of SEP in young adulthood and adulthood on a subset of 4 cohort studies (N=13 078). We also investigated whether health behaviours or BMI affected the association between life course SEP and inflammation. Our findings reveal a consistent inverse association between SEP and CRP across cohorts, where participants with lower SEP had higher levels of CRP. In most cohorts, and in the meta-analysis, educational attainment was the SEP indicator most strongly related to inflammation where low educational attainment was associated with higher log-transformed levels of CRP ( $\beta=0.30$ , 95% CI 0.22-0.38). Our findings also suggest that the higher CRP among the low educational attainment group was only partly attributable to BMI ( $\beta=0.19$ , 95% CI 0.11-0.28) and smoking ( $\beta=0.27$ , 95% CI 0.19-0.35). From this work, we conclude that socioeconomic circumstances across the life course are associated with higher levels of inflammation in adulthood, suggesting that social-to-biological processes are at play, beyond the impact of health behaviours and BMI.

### **O03.04.20. Modification of Asthma Clinical Trial Results by Environmental and Socioeconomic Exposures**

Jane Clougherty

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Abstract: Randomized clinical trials (RCTs), generally considered the gold standard of evidence in medical research, randomize and balance treatment and control arms, thereby maximizing internal validity, and reducing between-group biases resulting from variation in individual patient characteristics. This assumption may well hold true for the population accurately represented by the trial cohort, however RCTs do not generally control for environmental exposures and socioeconomic position (SEP), which may impact clinical outcomes, treatment response, and generalizability. To assess whether variation in SEP and environmental exposures across an asthma RCT cohort modify treatment response, we developed Geographic Information Systems (GIS)-based metrics to characterize residential exposures for the 221 children in the Step Up Yellow Zone Inhaled Corticosteroids to Prevent Exacerbations (STICS) study. On average, across the cohort, there was no significant effect of 5x increased corticosterone dose on a range of outcomes (e.g., exacerbation rate, albuterol use). We found, however, that higher roadway densities conferred a greater number of exacerbation events and unscheduled medical visits. Further, children in areas of greater poverty and home vacancy had significantly shorter times to first corticosteroid use. We are now examining near-residence roadway densities, poverty rates, and housing vacancy rates on variation in observed treatment efficacy. Using spatial analysis and GIS to understand the lived context of RCT participants - better accounting for socioeconomic and environmental factors - may help to improve the interpretation of RCT results, to better identify subpopulations for whom an intervention may be most effective, and to inform on the generalizability of RCT results.

## S03.04A. Chemical Policy in the 21st Century: Comparing Canadian, US, European and Asian Approaches

### **S03.04.01. The Perils and Promise of the 2016 Lautenberg Chemical Safety Act: A Critical Appraisal of the U.S. Experience**

Tracey Woodruff

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Abstract: In the U.S., people are exposed to multiple industrial chemicals, many of them known to cause adverse health effects (e.g. asbestos, methylene chloride). Further, 8,700 high production volume chemicals are largely untested for health effects. Many chemicals are not tested or regulated because of flaws in the law that governs chemicals in the U.S.-the 1976 Toxic Substances Control Act. In 2016, amendments called the Frank Lautenberg Chemical Safety for the 21st Century Act (Lautenberg TSCA) were finalized to address these gaps and directed the US Environmental Protection Agency (USEPA) to evaluate chemicals under enforceable deadlines against risk-based safety standards that account for susceptible subpopulations and with new powers to compel manufacturers to test products for safety. However, many scientific decisions are left to USEPA during implementation, including how to evaluate human and animal scientific evidence, define susceptibility and aggregate risk, incorporate new science into risk assessment, define conditions of use, and determine what constitutes an unreasonable risk. Actions by USEPA may preempt individual states from taking any further action on regulated chemicals. Implementation can either lead to public health protections or worsening of the deficits that have hampered U.S. chemical policy for the past 40 years. Effective public health protection requires strong implementation of Lautenberg TSCA, in which USEPA evaluates, assesses and limits exposures to multitudes of harmful chemicals, and corporations provide adequate evidence to evaluate hazards. This presentation will briefly introduce data needs and ways to improve the scientific basis, transparency and protection of vulnerable populations in chemical assessments under the new law. The role for epidemiologic studies and biomonitoring data from pregnant women will be featured. We recommend principles geared towards ensuring U.S. chemical policy that is truly public health protective.

## **S03.04.02. REACH Chemical Policy at 10 Years: A European Perspective on Lessons Learned**

Vito Buonsante

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Abstract: Effective chemical policy which accurately assesses potential chemical hazards to human health and the environment and appropriately restricts risky chemicals is vital because health impacts from industrial chemical exposures are preventable. Primary prevention through policy could significantly improve public health and reduce health costs, and the EU chemicals safety legislation REACH is a key framework. The presentation will briefly discuss major issues regarding epidemiologic and exposure data needs, improving risk assessments, and challenges to achieving public health protections based on 10 years of REACH implementation in the European Union and the Health and Environment Alliance's (HEAL) experience of European policy approaches to gathering data and assessing risk from environmental chemicals. HEAL's technical, scientific and policy work has focused within the European Chemical Agency (ECHA) as an official health stakeholder and active participation in several ECHA committees, including the ED Expert group, which focuses on evaluating substances with EDC properties, providing informal, non-binding scientific advice on questions related to the identification of ED chemicals. Our key objectives in providing the health evidence and public health advocacy: 1) EU and international chemicals policies take a precautionary approach by prioritising the phase out of hazardous chemicals and promotion of safer alternatives; particularly for endocrine disruptors, and 2) Risk assessments are based on assessing harm to vulnerable groups; and incorporate chemicals mixtures and multiple exposures HEAL and its scientific experts provide health expertise for chemicals that are under assessment for being placed on REACH's candidate list, meaning that they would be subject to future restrictions, including high profile chemicals and test cases such as glyphosate, PFOAs, BPA, phthalates.

### **S03.04.03. Canadian Chemical Management Plan's Successes and New Directions**

Miriam Diamond

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Abstract: The Canadian Environmental Protection Act (CEPA) was proclaimed in 1999 as overarching legislation guiding pollution prevention and chemical management. Within CEPA, the Chemical Management Plan (CMP) was implemented to undertake chemical adjudication and management. In CEPA, risk-based toxic substances management is based on: (1) the greatest potential for human exposure and (2) Persistence, Bioaccumulation and inherent Toxicity characterizations. With 23,000 substances on the Domestic Substances List, 4,300 substances were identified for human health and ecological health assessments between 2011 and 2020 with the remainder designated as low priority. Also screened annually are 400 to 500 New Substances Notifications. The main data gaps challenging the human health assessments have been in exposure and toxicity. Biomonitoring under the Canadian Health Measures Survey and specific epidemiological studies have filled some gaps in exposure data. Without such data (and even when this is known), forward dosimetry has been based on substance usage data mostly provided by industries and pathway modelling. Much interest in CMP has come for using "New Approach Methodologies" or NAMs that include in silico, in chemico and in vitro toxicity assays. A framework is being developed for using "Read across" methods for approximating the toxicity of substances with limited data. The success of Canada's Chemical Management Plan was the initial screening categorization process of the 23,000+ substances and the nearly completed risk assessments of 4,300 substances. Assessors have incorporated new methods as the assessment process is not overly prescribed and hence flexible. CEPA will be updated shortly with the likely consideration of vulnerable populations, occupational exposure, cumulative effects, and the need to deal with chemical mixtures. Challenges remain regarding assessment over the life cycle of a chemical and how to best maintain a flexible approach that allows for innovation.

#### **S03.04.04. Human Biomonitoring as a Tool to Support Chemicals Regulation**

Catherine Ganzleben

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Abstract: The European Human Biomonitoring Initiative, HBM4EU, represents a joint effort of 26 countries and the European Commission, co-funded by Horizon 2020. The main aim of the initiative is to coordinate and advance human biomonitoring in Europe. HBM4EU is providing better evidence of the actual exposure of citizens to chemicals and the possible health effects to support policy making. The project involves collaboration between several Commission services, EU agencies, national representatives, stakeholders and scientists, demonstrating how research funding can build bridges between the research and policy worlds. HBM4EU kicked off in January 2017 and will run for 5 years until December 2021. HBM4EU will contribute to the overarching goal of ensuring that EU chemical policies minimise the adverse effects of chemicals on human health. In this presentation, accomplishments to date and future research goals of the European Human Biomonitoring Initiative (HBM4EU) will be presented. This will include reflections on opportunities in EU chemical risk assessment and risk management for using HBM results.

### **S03.04.05. New Chemical Safety Policy in Korea to Achieve Public Health Protection: Experience of K-REACH**

Jong Han Leem

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Abstract: The "Law on the Registration and Evaluation of Chemical Substances," in Korea (K-REACH) requires all new chemical substances and existing chemical substances manufactured, imported and sold for more than 1 ton per year to be registered at the Environment Protection Agency or the local environment agency. By law imports and sales volume should be reported, and hazard and risk should be examined and evaluated. It was enacted on May 22, 2013, with the need to strengthen the management of chemical products in the wake of the death of the humidifier disinfectant in 2011, and has been in effect since January 2015. K-REACH has been evaluated as being the most similar to EU REACH in Asia. On August 16, 2017, Korean government submitted a bill, named as Consumer Chemical Products and Biocides Safety Control Act to the National Assembly. This will come into effect on January 1, 2019. Similar to the EU Biocidal Products Regulation, Korean Biocides Bill introduces a market pre-approval system for active substances and biocidal products, by applying "No Safety, No Market" principle. It strengthens risk communication, through disclosing information related to the entire component and risks of the biocides. The K-REACH, Chemical Control Act, and Chemical Products and Biocides Safety Control Act which are regarded as advanced systems, still has many difficulties. Especially, it is the industry's objection that the industrial sector has the problem that the scope of reporting and registration of substances is too wide in K-REACH, and Biocides Safety Control Act. The industrial sector complained that this new acts give too heavy burden to the industrial sector. But environmental NGO and civil organizations protested against too many exception and exemption in this acts and insisted that no matter how small the distribution, the toxic substances, such as substances of very high concern (SVHCs) must be registered and managed.

## S02.02B. Exposure and Risk Assessment of Chemicals in Consumer Articles

### S02.02.06. High-Throughput Exposure Modeling: Conclusions of the ExpoDat Program

Hyeong-Moo Shin

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**Abstract:** Background: While a growing number of chemicals have been introduced into commerce over the past several decades, there is a dearth of exposure and toxicity information available to assess potential harmful effects of these chemicals to humans. The immediate needs for rapid, or high-throughput (HT), exposure assessment were identified from ExpoDat, a program developed as part of the American Chemistry Council's Long-Range Research Initiative. Objective: To discuss limitations and potential improvements in HT exposure modeling of chemical exposure from the ExpoDat program efforts. Methods: As part of ExpoDat, 180 organic chemicals that had at least one ToxCast in vitro assay hit were selected to identify chemicals for potential health concerns. For comparison with the ToxCast assay, a series of models were applied to estimate exposure in a HT manner. For each chemical and use scenario, exposure models were used to calculate a chemical intake fraction, or a product intake fraction, accounting for chemical properties and the exposed population. These intake fractions were then combined with use scenario-specific estimates of chemical quantity to calculate daily intake rates (iR). The iRs were compared with those inferred from biomonitoring data in the National Health and Nutrition Examination Survey (NHANES). Results: Overall, iRs were overestimated. For compounds with multiple exposure pathways, estimated maximum iRs were much greater (up to 7 orders of magnitude) than the 95th percentile iRs inferred from biomonitoring data. Lack of data on allocation of chemical quantity to each use scenario and on relevant exposure pathway was identified as a primary source of uncertainty in exposure prediction. Conclusions: The method provides HT estimates of exposure, but identifying relevant pathways and chemical quantity allocation is needed to avoid overly conservative estimates.

## **S02.02.07. Rapid Parameterization of Pathway-Specific Exposure Models**

Kristin Isaacs

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Abstract: Evaluation of biomonitoring data supports the importance of near-field chemical exposure pathways. High throughput (HT) exposure models for consumer products have been developed, but require large amounts of composition, product use, and exposure factor data. EPA's ExpoCast program has worked to obtain and organize publicly-available information for thousands of chemicals to support these models. However, challenges arise in evaluating the applicability of these data to new models, chemicals, products, uses, or populations. Thoughtful model design and data organization can promote reuse of collected information, as can the definition of formal linkages among model inputs and model algorithms describing exposure processes. For example, efficiently modeling chemicals in consumer products is enabled by a fit-for-purpose system of consumer product categories. Categories can be linked to generic exposure scenarios that define indoor fate and transport, route-specific intake, and disposal, and to associated product-specific factors (e.g., use and release patterns), to create a library of fully parameterized algorithms. In this framework, obtaining results for a new chemical does not require de novo parameterization, only knowledge of its concentration in products. In addition, defining generic chemicals within categories (e.g., via Latin hypercube sampling of physicochemical space for chemicals in products) will allow for rapid read-across of exposure results. While near-field models may adequately capture chemical-to-chemical variability in population median exposure, new HT ambient exposure (e.g., associated with industrial releases) or occupational exposure models will be required to address populations having outlier exposure patterns. Obtaining and organizing available data and algorithms for these populations is a current focus in ExpoCast. This abstract may not reflect U.S. EPA policy.

## S02.02.08. Modeling on Many Scales - Multiscale Modeling of Exposure to Chemicals in Products

Olivier Jolliet

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Abstract: Informing decision about chemical alternatives and related exposure to chemicals in consumer products necessitate to cover both far and near-field exposure over a range of scales and receptor populations. Building on USEtox, we present a suite of models covering a) near-field direct exposure of consumers to chemicals in products and in indoor air, and b) the far-field environmental and human exposure associated with localized chemical releases. In addition to the continent specific calculations of USEtox, a spatialized adaptation of USEtox is implemented on the multi-scale multimedia Pangea modeling platform, with 120000+ cells from 10km to global scale and using the high resolution global hydrological dataset HydroBASINS. We first apply the model to four chemicals used across Asia, selected to cover a variety of applications, volumes of production and emission, and physico-chemical and environmental fate properties: The anionic surfactant linear alkylbenzene sulphonate (LAS), the antimicrobial triclosan (TCS), the personal care preservative methyl paraben (MeP), and the emollient decamethylcyclopentasiloxane (D5). LAS emission levels and Predicted Environmental Concentrations are two to three orders of magnitude greater than for other substances. We observe a good agreement for TCS in freshwater ( $r=0.82$ , for 253 monitored values covering 12 streams), the substance with most data, whereas the model underestimate MeP sediments concentrations. Intake fraction and spatialized intakes are also determined both for the near field and spatially for environmentally mediated exposure in Australia. The direct indoor exposures are dominant, whereas we observe high spatial variation in intake fractions from 0.68 to 33 ppm for benzene emitted in ambient air, which travels over longer distances, and from 0.006 to 9.5 ppm for formaldehyde that has a more local impact. We finally discuss strengths and weaknesses of each of these complementary tools.

## **S02.02.09. Evaluating Exposure Models**

Jon Arnot

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Abstract: Exposure models are required to support decision-making in different regulatory assessment contexts (e.g., prioritization, screening-level, and comprehensive). Exposure models provide frameworks for integrating and interpreting exposure information (e.g., emission/use rates, monitoring/biomonitoring data) and for making exposure predictions in the absence of any measured exposure information (e.g., data-poor chemicals for prioritization). Ostensibly, the acceptable magnitude of uncertainty varies depending on the decision and model application contexts. In order to use the models with confidence in chemical assessments there is a requirement to understand: (i) the uncertainty in the model calculations, (ii) the chemical and exposure scenario applicability domains of the models, (iii) the merits and limitations of the models, and (iv) the availability and uncertainty in model input parameters necessary to use the models. Common methods for characterizing model sensitivity and uncertainty will be illustrated with a series of case studies. The case examples show the sensitivity of exposure estimates to chemical use and quantity information, degradation and biotransformation rates, and chemical partitioning properties. Model performance can be quantified by comparing exposure predictions with monitoring and biomonitoring data. In the absence of any measured data (e.g., "data-poor" chemicals) comparisons of different exposure model predictions for the same chemicals and use scenarios can provide insights into the collective uncertainty of the models (e.g., agreement vs. disagreement in exposure estimates) thus providing strategic guidance for research needs to address this uncertainty. Methods for merging available measurements with exposure models (e.g., higher-tiered assessments) to characterize uncertainty and address data gaps in exposure estimation are also demonstrated.

## **S02.02.10. Systematic Empirical Evaluation of Models for Risk Prioritization**

John Wambaugh

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Abstract: Prioritizing the potential risk posed to human health by the thousands of chemicals that occur in commerce and the environment requires tools that can estimate exposure from limited information. High-throughput exposure (HTE) models exist to predict exposure via specific pathways. We consider an "exposure pathway" to include a chemical source, interaction with the environment, and a receptor (such as a person). Data for identifying the relevant pathways for chemicals in a high throughput manner are limited. Both expert opinion and conservative assumptions (all chemicals via all pathways) have drawbacks. Here we present a consensus HTE model based on 15 models and databases drawn from a collaboration involving five universities, a research consultancy, and the U.S. EPA. Machine learning predicts the probability that a chemical is associated with four assumed pathways: near-field (residential), dietary, far-field industrial, and far-field pesticide. On a pathway basis, we examine inferred chemical intake rates for the median U.S. population, from the National Health and Nutrition Examination Survey (NHANES). The intake rate for each pathway is either higher (residential, dietary) or lower (pesticidal, industrial) than the average. We use multivariate linear regression to evaluate the predictive ability of each model and database to raise or lower exposure with respect to the pathway averages. We can explain ~70% of the chemical-to-chemical variance in NHANES using the consensus model. We extrapolate model predictions to other chemicals by assuming that chemicals without biomonitoring data will have similar intake rates to those within NHANES. Predictions with quantified confidence intervals may allow risk-based prioritization using the margins between putative bioactive doses and intake rate predictions. This abstract may not reflect U.S. EPA policy

## S03.04C. Effects of Long-Term Exposure to Ambient Air Pollution in the Asia-Pacific Region

### S03.04.11. Long-Term Effects of PM<sub>2.5</sub> on Total Mortality in Seoul, Korea

Hyun-Joo Bae

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**Abstract:** Background: Cohort studies in North America and western Europe have reported increased risk of mortality associated with long-term exposure to fine particles (PM<sub>2.5</sub>), but to date, no such studies have been reported in Korea, where higher levels of exposure are experienced. Objectives: We estimated the association between long-term exposure to PM<sub>2.5</sub> with total mortality in a cohort of Korean. Methods: We conducted a prospective cohort study of 4,171,410 residents 30-year-old or older from 25 areas in Seoul in 2008 and followed-up the cohort until 2015. Average PM<sub>2.5</sub> levels for the 12 or 24 months prior to death were estimated for each cohort location using a Krigging. A Cox proportional hazards regression model was used to estimate hazard ratios (HR) for total mortality after controlling for age, sex, income, year of event, population, area-level socioeconomic indices, and prevalence of chronic obstructive pulmonary disease. Results: The mean level of 12- and 24-month average of PM<sub>2.5</sub> exposure was 22.9 µg/m<sup>3</sup> (S.D. 1.6) and 23.8 µg/m<sup>3</sup> (S.D. 1.3). Of Seoul residents, 228,329 of death occurred (5.47%). Mortality HRs (95% CI) per 1-µg/m<sup>3</sup> increase in PM<sub>2.5</sub> were 1.046 (95% CI, 1.043, 1.048) and 1.056 (95% CI, 1.051, 1.059) for 12- and 24-month exposures, respectively. Conclusions: Long-term exposure to PM<sub>2.5</sub> was associated with total mortality in Seoul, Korea.

### **S03.04.12. Long-Term Exposure to Air Pollution and All-Cause and Cause-Specific Mortality in Okayama, Japan**

Takashi Yorifuji

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Abstract: A number of studies have linked long-term exposure to air pollution, especially particulate matter with aerodynamic diameter  $< 2.5 \mu\text{m}$  (PM<sub>2.5</sub>), with cardiovascular disease and lung cancer mortality. But, most of the studies were conducted in the United States and Europe. Although literature is being accumulated, evidence is still limited in Asian countries. We therefore evaluated the association of long-term exposure to air pollution, especially PM<sub>2.5</sub>, and all-cause and cause-specific mortality among a cohort study in Okayama, Japan. We followed up a cohort of 76,591 participants who were enrolled in regular health checkups held in Okayama City in 2006 and 2007. After obtaining the participants' addresses at the census level, we assigned modeled PM<sub>2.5</sub> data provided from the Atmospheric Composition Analysis Group to the participants. We evaluated mortality outcomes through record linkage to the vital statistics from the Ministry of Health, Labour, and Welfare in Japan. We focused on all-cause and cause-specific mortality such as cardiovascular disease and lung cancer as main health outcomes. We used Cox proportional hazard models adjusting for individual-level potential confounders and area-level socioeconomic status in the model. We present the findings in the symposium.

### **S03.04.13. Long-Term Exposure to PM2.5 Components and Cardiovascular Mortality in a Chinese Cohort**

Haidong Kan

*Haidong Kan<sup>1</sup>*

*1. Fudan University, Shanghai, China.*

Abstract: Few prior cohort studies exist in developing countries examining the association of ambient fine particulate matter (PM2.5) components with mortality. We examined the association of PM2.5 components with cardiovascular mortality in a prospective cohort study of 61,768 participants in 161 Chinese cities. Baseline data were obtained during 2010-2010. The participants were followed up from 2011 to 2015. Annual average concentrations of PM2.5 components between 2011 and 2015, including elemental carbon (EC), organic carbon (OC), sulphate (SO4<sup>2-</sup>), nitrate (NO3<sup>-</sup>) and ammonium (NH4<sup>+</sup>), were estimated by the Community Multiscale Air Quality (CMAQ) model. As the results, we found significant associations between PM2.5 and mortality from cardiovascular diseases; each 10 µg/m<sup>3</sup> PM2.5 was associated with a 2.8% (95CI: 0.7%, 4.8%), 3.2% (95CI: -0.3%, 6.8%) and 4.6% (95CI: 1.8%, 7.5%) increased risk of cardiovascular, coronary heart disease and stroke mortality, respectively. An interquartile range (IQR) increase of EC, OC, SO4<sup>2-</sup>, NO3<sup>-</sup> and NH4<sup>+</sup> were associated with 17.7% (95CI: 7.8%, 28.5%), 16.6% (95CI: 6.1%, 28.2%), 3.8% (95CI: -6.2%,14.8%), 26.7% (95CI: 10.6%,45.2%), and 17.8% (95CI: 4.3%, 33.0%) increase of cardiovascular mortality, respectively. Conclusively, these data contribute to the scientific literature on long-term effects of particulate air pollution for high exposure settings typical in developing countries.

### **S03.04.14. Long-Term Exposure to Low Level Air Pollution in Sydney and Mortality and Hospital Admission Using the '45 and Up' Cohort: Methodological Challenges**

Bin Jalaludin

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**Abstract:** We used the '45 and Up' cohort study of older (45+ years) residents of New South Wales, Australia, to investigate the health effects of long term air pollution exposure. Individual level data was collected on 267,153 subjects via baseline questionnaire mostly completed in 2008 and these data were linked to routinely collected death registrations data (up to 2015) and hospital admissions data (up to 2014) via personal identifiers (including age, sex, residential address). Neighbourhood level socio-economic status data was linked to study subjects residential address. Subjects residential address was used to estimate annual average NO<sub>2</sub> exposure using a satellite based land use regression model for 2007 for all study subjects, while Chemical Transport Model data blended with fixed site monitor data for 2010/11 was used to estimate annual average PM<sub>2.5</sub> exposure for subjects in the Sydney metropolitan area. We implemented Cox proportional hazards models to assess the associations between air pollution exposure and all-cause mortality, and respiratory hospital admissions while adjusting for individual level socio-demographic and behavioral factors, as well as area-level factors. Annual average PM<sub>2.5</sub> and NO<sub>2</sub> exposure was 4.5 µg/m<sup>3</sup> and 17.5 µg/m<sup>3</sup> respectively. Covariate adjusted models found that mortality and respiratory hospital admissions were associated with PM<sub>2.5</sub> and NO<sub>2</sub> (mortality Hazard Ratios (HR)=1.06 (95% CI: 1.00-1.11), asthma admissions HR=1.08 (95% CI: 0.89 - 1.30), bronchitis admissions HR=1.32 (95%CI: 0.96 - 1.80) per 1 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> respectively). Increasing model complexity generally reduced the magnitude of the HR point estimates and the strength of the associations but may have resulted in over control for covariate effects. Even at the relatively low level long term air pollution exposures generally seen in Sydney, and with limited follow up, air pollution exposure within our cohort had a detrimental effect on mortality and hospitalisation.

### **S03.04.15. Lessons Learned from the ESCAPE Project**

Bert Brunekreef

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Abstract: The European study of cohorts for air pollution effects (ESCAPE) was a large-scale effort including data from about 35 different cohort studies conducted in Europe. The cohorts included birth cohorts, respiratory morbidity cohorts, cardiovascular morbidity cohorts, and cohorts focused on lung cancer and mortality. Measurement campaigns were carried out for nitrogen oxides and airborne particulate matter in all areas where study participants lived. The measurement data were then used to develop land-use regression models explaining the spatial variability of the air pollution concentrations. These models were subsequently used to estimate air pollution concentrations at the home address of the study participants. A variety of outcomes were studied. For most endpoints, data were analysed within the individual cohorts and results combined by meta analyses. Many lessons were learned from the escape project, especially related to the importance of strict adherence to protocols for air pollution measurements, exposure modelling, and epidemiological data analyses within the individual cohorts. A pooling effort in the analyses on birthweight showed a clear gain in efficiency over doing just a meta-analysis. In a follow-up study the emphasis is now on pooling individual data from participating cohorts. The escape project also served as a training ground for many young researchers working in the different participating study teams. Authorships were widely shared among the study teams and first authorships were often allocated to young researchers such as PhD students and postdocs. This strategy contributed to enthusiasm and commitment among the study teams without which the study could not have been carried out as it was.

S03.04D. Exposure to Pesticides and Heavy Metals in the African Context: Electronic Waste, Artisanal and Small-Scale Mining, and Indoor Residual Spraying

**S03.04.16. Neurodevelopmental Outcomes of Children Exposed to Lead in Selected Locations of Kabwe District in Zambia**

Nosiku Munyinda

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Abstract: Kabwe, the provincial headquarters of the Central Province of Zambia has been the principal producer of lead (Pb) and Zinc (Zn) since the early 1900's. The consequent pollution arising from unregulated mining and smelting of Pb, Zn and Cadmium (Cd) and the production of sulfuric acid is massive. The intense environmental contamination has resulted in Blood Lead Levels (BLLs) in children between 60 and 120 µg/dL. A 2006 study concluded that there could be 650 cases in Kabwe and the surrounding communities with BLL > 65 µg/dL, levels that could induce sub-acute toxicological effects. These high-Pb soils and BLL have resulted in Kabwe being named among the top ten most polluted places in the world. Lead is known to negatively affect neurological development, but to date there is no known study that explores the differential exposure levels and pathways over time during the most crucial periods of neurological development in pregnancy and the first two years after birth in Africa. For the babies, a physical examination including a new-born exam, height, weight, head circumference was done. These were analyzed taking into account potential confounders related to baseline health status, socio-economic status and other individual characteristics of the mothers. The Ages and Stages Questionnaire (ASQ), extensively used to assess the development of infants, was used for the Neurodevelopmental Assessment. The results revealed median BLLs of 35.1mg/dl (IQR 0 - 381.6) for all the areas. Significant associations were found between proximity to the mine and the BLLs. Mean scores for communication, gross motor, fine motor, problem solving and personal social domains were 44, 44, 40, 37 and 38 across all the areas. There were significant differences across the areas with lower scores below the cutoff points recorded in areas which recorded higher Blood Lead Levels in the children.

### **S03.04.17. Mercury Exposure Biomarkers and Neurologic Measure Differences between Registered and Unregistered ASGM Miners in Ghana**

Nil Basu

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Abstract: Workers within artisanal and small-scale gold mining (ASGM) communities are amongst the highest Hg-exposed groups worldwide. While formalization of this sector has been suggested as a means to reduce exposures and improve health and safety, we are unaware of empirical evidence that supports this notion. The objective of this study was to compare mercury exposure profiles and neurologic measures among miners working in licensed versus un-licensed ASGM sites. To achieve this, 404 small-scale miners were recruited in 2014 from 9 mining sites in Tarkwa (Ghana), of which 5 were licensed and 4 were not licensed. Miners were interviewed, performed a range of neurologic tests and surveys, and urine and hair samples were taken for measurements of total Hg content in a subset (n=316). Sociodemographic characteristics of miners from the two groups were relatively similar (33.8 yrs old, 92% male, 29% completed high school, 66% living with a partner). Those currently working in an un-licensed mine have higher mean levels of total Hg in urine (110.7 vs 16.0 ug/L;  $p < 0.001$ ) and hair (4.5 vs. 2.0 ug/g;  $p = 0.09$ ) compared to workers from the licensed mines. A range of other information was collected showing differences between these groups of miners such as work history and injury episodes, and these will be discussed. Neurological measures (e.g., gait, peripheral outcomes) are being finalized. These findings advance our understanding of mercury exposure (and other differences) amongst ASGM workers especially important differences between miners working in a licensed versus and un-licensed site.

### **S03.04.18. Agbogbloshie Electronic Waste Recycling Site: A Case of Focal Environmental Contamination**

Julius Fobil

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"Abstract: Accra, the capital city of Ghana is home to one of Africa's largest informal e-waste dumpsite and scrap yard. This dumpsite, which is popularly called "Sodom & Gomorrah" or "Agbogbloshie" and/or "Old Fadama" in most other instances, started to develop as a settlement in the early 1980s by migrants fleeing communal violence in the parts of the country who found habitation on what used to be a mangrove swamp or waste/wetland. Agbogbloshie is now known for its mixed economy where both formal and informal economic activities co-exist and infamous for raucous noise due to vehicular traffic, itinerant merchant population and clientele, automobiles and large plumes of smoke emanating from e-waste recycling activities under intensely scorching sun. This combination of economic activities from both formal and informal has resulted in extensive localized environmental pollution from heavy metals and persistent organic pollutants in the ambient environmental media - air, soil/sediment and water. In particular, the concentrations copper (Cu) and iron (Fe) has been reported in sampled soil mixtures collected from the sites as 289 mg/kg and 222mg/g for Cu and Fe respectively; while lead (Pb) concentrations ranged from 134 part per million (PPM) to 18,125 PPM. Overall, organics such as polybrominated diphenyl ethers (PBDEs) have been measured in soil samples at Agbogbloshie and the results showed concentrations that ranged from 15.6 to 96.8ng/g. "

### **S03.04.19. Exposure to DDT and Pyrethroid Insecticides and Humoral Response to Vaccines among South African Children from an Area Sprayed for Malaria Control**

Jonathan Chevrier

*Jonathan Chevrier<sup>1</sup>, Brian Ward<sup>1</sup>, Thomas Di Lenardo<sup>1</sup>, Riana Bornman<sup>2</sup>, Muvhulawa Obida<sup>2</sup>, Brenda Eskenazi<sup>3</sup>*

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Abstract: Animals studies strongly suggest that exposure to insecticides such as DDT and pyrethroids inhibit immune response to vaccines. However, few human studies have investigated this question and none have done so in communities where insecticides are used to control malaria as part of Indoor Residual Spraying programs. These communities experience high exposure to insecticides and may be particularly susceptible to their toxic effects due to poverty, malnutrition and poor health. Our objective was thus to evaluate whether prenatal exposure to DDT and pyrethroids was associated with reduced immune response to vaccines at age 3.5 years among South African children participating in the Venda Health Examination of Mothers, Babies and their Environment (VHEMBE) birth cohort study. Between August 2012 and December 2013, we enrolled 752 women when they presented for delivery at Tshilidzini hospital in the city of Thohoyandou. We collected urine and blood samples at delivery for the measurement of pyrethroid metabolites and DDT via gas chromatography-mass spectrometry, respectively. At age 3.5 years, we collected child blood samples and measured measles, tetanus and Haemophilus influenzae b (Hib)-specific 1) antibody titers via enzyme-linked immunosorbent assay (ELISA) and polyfunctional transitional, central and effector memory CD4+ T cells. Initial analyses suggest that each 10-fold increase in maternal DDT serum concentration is associated with a 75% (95%CI=-15, 306) increased risk of measles antibody seronegativity and a 5.2-fold (95%CI=1.5, 17.5) increase in the risk of detecting no transitional memory CD4+ T cells expressing TNF- $\alpha$  and IFN- $\gamma$ . Pyrethroid metabolites cis-DBCA and 3-PBA were primarily associated with reduced measles- and tetanus-specific central memory CD4+ T cells expressing TNF- $\alpha$  and IL-2. Overall, results suggest that exposure to DDT and pyrethroids may inhibit immune response to vaccines among South African children.

## S03.04E. Exposure, Vulnerability, and Capacity Assessment for Health Risks of Climate Change: Measuring and Communicating the Effectiveness of Interventions and Policy Responses

### **S03.04.21. Climate Change and Health Stress Testing**

Kristie Ebi

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**Abstract:** Background: Climate change and its consequences can result in shocks and stresses that may affect population health and health systems. The extent to which health systems are prepared for and have the capacity to manage risks will determine their resilience in coming decades. Modifying current programs to manage each climate-related hazard separately may lead to inadequate preparation to manage multiple and synergistic exposures. Methods: Conducting a climate change and health stress test goes directly to the question of how well health systems could manage extreme weather and climate events, climate-sensitive disease outbreaks, and other climate-related possibilities outside the range of historic experience. A climate change and health stress test consists of three stages: (1) preparation, including identifying priority climate-sensitive health outcomes for the stress test and developing desk-based hypothetical situations (scenarios) that would shock or stress the capacity of health systems; (2) conduct a climate change and health stress test workshop to evaluate the extent to which communities and health systems would likely be able to manage the shocks and stresses, and identify additional resources, tools, and policies that could prevent adverse population health consequences associated with the hypothetical situations; and (3) summarize and prioritize the recommendations and communicate to key stakeholders. Results: Conducting a climate change and health stress test can facilitate understanding shocks and stresses that could overwhelm health systems, and identifying options to increase the capacity of communities and health systems to prepare for and manage the climate-related shocks and stresses that could occur over coming decades.

## **S03.04.22. Reducing Morbidity and Mortality Due to Extreme Heat: A Call for Evidence-Based Interventions**

Gregory Wellenius

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Abstract: Extreme heat is an established and significant threat to public health across the globe. We estimate that in the US extreme heat events (defined as temperatures  $\geq$  97.5th percentile of local daily mean temperature) account for approximately 3,658 deaths per year, and the impact of heat on the risk of non-fatal events such as hospitalizations and emergency department visits is likely even larger. National analyses suggest that projected climate change could lead to thousands of additional deaths per year due to extreme heat. Additional adaptation measures at the individual, household, and community levels will be essential to avoid the worst of these health impacts. Many communities have already implemented adaptation measures in order to reduce heat-related morbidity and mortality in the present and the future. For example, in Philadelphia, New York City, and across New England, the research community and key stakeholders have collaborated to refine the guidelines for issuing National Weather Service (NWS) heat advisories or excessive heat warnings with the aim of better protecting people in the face of extreme heat events. Implementation of these and other adaptation measures should be viewed as a critical step in the right direction. However, there is relatively little evidence regarding the effectiveness of existing or emerging approaches to reduce heat health impacts, and the available evidence is mixed. For example, our recent findings suggest that NWS heat alerts between 2001 and 2006 were not associated with appreciable reductions in rates of death or hospitalization in most locations, potentially missing a valuable opportunity to avert a substantial number of heat-related deaths. Emerging results highlight the need to better link heat warning systems to effective intervention strategies to reduce heat-related health effects, as well as the need for adaptation efforts to be based on rigorous evidence of which approaches are likely to be most effective.

### **S03.04.23. Early Warning System for Infectious Diseases at the European Center for Disease Prevention and Control (ECDC)**

Jan Semenza

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Abstract: As part of climate change adaptation, early warning of environmental precursors of diseases constitutes a proactive public health intervention. It entails risk analysis, monitoring of environmental precursors of disease through sensors, event detection, warning, communication, dissemination, and response. The intent is to forecast an epidemiological event by providing lead-time for a rapid response in order to prepare for adverse consequences and to minimize its impact. The European Centre for Disease Prevention and Control (ECDC) has developed a quasi-real-time, web-based platform, the ECDC Vibrio Map Viewer, to monitor environmentally suitable marine areas for *Vibrio* growth using remotely sensed sea surface temperature and salinity. *Vibrio* spp. are aquatic bacteria that are ubiquitous in warm estuarine and coastal waters with low to moderate salinity; the environmental suitability of *Vibrio* growth in the Baltic Sea is projected to expand in a warming climate. *V. parahaemolyticus*, *V. vulnificus* and non-toxicogenic *V. cholerae* (non-O1/non-O139) are pathogenic in humans, although they are not responsible for widespread epidemics. ECDC generates weekly forecasts and potential alerts that are disseminated to public health decision makers, along with different response options for their consideration: public access to a beach should be temporarily denied for public safety purposes; warnings should be issued when the environmental suitability of *Vibrio* infections is imminent; or alerts should be issued to notify health care providers and at risk individuals, such as the immune-compromised.

**S03.04.24. Title: Assessing Health Vulnerability and Adaptation to Climate Change: Health Canada's Guidance for Public Health Officials**

Peter Berry

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Abstract: Climate variability and change are increasing risks to the health of Canadians in communities across Canada. Addressing the challenges posed by climate change requires knowledge of risks from current climate hazards, projected impacts of future climate change, the unique vulnerabilities facing specific populations, communities or regions, and measures to effectively protect health. An increasing number of health authorities from local to national levels in Canada are undertaking assessments to expand understanding of climate change impacts on health and adaptation options, educate and engage stakeholders and the public and influence policy development. Climate change and health vulnerability and adaptation assessments: (1) Provide information on the expected distribution and severity of future climate change and health impacts to health and emergency management officials, stakeholders and the public; (2) Inform efforts to mainstream information on the health impacts of climate change into existing policies and programs and/or develop new initiatives to reduce the health impacts of climate change; and (3) Support the development of inter-sectoral relationships and collaborations to influence upstream determinants of health in the context of greater climate change stressors. Building on assessment guidance developed by the World Health Organization, Health Canada developed the "Climate Change and Health Vulnerability and Adaptation Assessment Workbook" that integrates greater considerations of gender and Indigenous Population issues and knowledge into assessment steps along with guidance and indicators for gauging the resilience of health systems and services to climate change impacts.

### **S03.04.25. Climate Change Policy: What Has Happened? What Can We Do?**

Mary Rice

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"Abstract: In 2015, at the Conference of Parties 21 Summit in Paris, nearly every country on the planet agreed to set "nationally determined contributions" to limit greenhouse gas emissions, with the goal of holding the increase in the global average temperature to below 2 °C above pre-industrial levels. Since then, the United States has indicated it will pull out of the Paris agreement and has rolled back regulations to reduce emissions from power plants and motor vehicles. Key policy developments in the United States, Europe and China will be reviewed, with a focus on how health effects research has informed climate policy. The presentation will conclude with a discussion of the role of physicians and scientists as educators and advocates for health-conscious energy policy. "

## S03.04F. Exposures to Emerging Trace Elements

### S03.04.26. Assessing and Reducing Risks from Mining of Technology Critical Elements

Michael Parsons

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**Abstract:** In recent years, there has been a rapid increase in the global demand for many elements used in green energy and high-tech applications, including antimony (Sb), cobalt (Co), indium (In), lithium (Li), niobium (Nb) and the rare earth elements (REE). Canada has abundant resources of these critical elements, and many companies are working to bring new mines into production. However, we know very little about the potential environmental impacts of mining critical elements compared to mining other commodities such as gold or copper. Processing resources such as REEs has led to environmental degradation in some parts of the world, but there are few published studies of these environmental impacts and related risks to human health. This talk will summarize the key geoenvironmental characteristics of critical element deposits, including results from recent studies of the St. Lawrence Columbian Mine in Oka, Quebec. This mine operated from 1961 to 1976 and at the time was one of the largest Nb producers in the world. Samples of waste rock, tailings, slag, surface water, and groundwater were collected from 2015 to 2018. Mineralogical analyses show that in waste rock and tailings most uranium (U), thorium (Th) and REEs are hosted by low-solubility oxide and silicate minerals. However, some REEs and fluorine (F) are contained in minerals such as calcite and fluorapatite, which are relatively soluble under weathering conditions. Smelter slag at the mine contains concentrations of U, Th and radioactive isotopes that exceed Canadian guidelines for the disposal of radioactive waste. Measurements of U, Th, F, Nb, REEs, and radionuclides in tailings seepage and pit lake waters indicate that these elements are relatively immobile in oxic surface waters, but may be transported in deeper, anoxic groundwaters. The results of this research should help to improve environmental predictions for future Nb- and REE-mining projects and support the development of new environmental guidelines.

### **S03.04.27. Using Hair Analysis to Assess the Exposure Level of Rare Earth Elements among Rural Housewives**

Bin Wang

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Abstract: Several studies have observed that population living near coal mining areas may have higher exposure level of rare earth elements (REEs). However, it is still a challenge to assess their exposure level of REEs, and the adverse effects of REEs on human health were also rarely investigated by an epidemiological study. Our study aimed to use hair analysis to assess their exposure level of REEs among women in Shanxi Province, which has the leading coal production around the world. In addition, we investigated the associations between hair concentrations of REEs and risk of hypertension among female adults and fetal neural tube defects (NTDs). About 14 concerned REEs in the specific hair sections were analyzed including lanthanum, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium, cerium, praseodymium, and neodymium. Population exposure level to indoor air pollution from coal combustion (IAPCC) was evaluated by the questionnaires of energy usage characteristics and life style. It was observed that hair concentrations of 13 REEs were overall positively correlated with the exposure level of IAPCC, except for europium. For the rural women, our study results revealed that the hair concentrations of the 14 REEs, except for europium, in hypertensive case women were higher than those in controls. The univariate odds ratios (ORs) of the 14 REEs were systematically > 1, of which four REEs (i.e. dysprosium, thulium, ytterbium, and yttrium) had adjusted ORs > 1. In addition, we found that hair REEs concentrations grown during the early pregnancy had potential adverse effect on NTD risk. It was concluded that hair REEs could be used as a marker to indicate population exposure level to REEs and may be a risk factor of the development of hypertension and fetal NTDs.

### **S03.04.28. Assessing Potential Exposure to Rare Earth Elements in Household Dust Via the Inhalation Exposure Pathway**

Albert Juhasz

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**Abstract:** As the commercial importance and prevalence of rare earth elements (REE) in consumer products grows, information about REE concentrations in the indoor environment has become increasingly relevant. Household dust acts as a sink for a wide variety of compounds from consumer products, building materials and outdoor sources, and is a useful medium for assessing residential exposures. This study investigated potential human exposure to REE in household dust via the inhalation exposure pathway. Household dust, collected from homes in 13 cities across Canada, was characterised for its elemental composition. Among the REE, cerium, lanthanum, neodymium and praseodymium were most prevalent with higher concentrations observed in homes of smokers compared to non-smokers. This was attributed to particles of mischmetal alloy emitted from cigarette lighter flints. Following household dust fractionation to a particle size of < 10 µm, potential REE exposure was assessed using an inhalation in vitro assay encompassing Hatch's solution as a simulated lung fluid. The inhalation assay was linked to the ingestion pathway by extending the assay to include gastrointestinal (GI) solutions. This simulated a scenario where following inhalation, household dust was cleared from the lung, swallowed and passed through the GI tract. Variability in REE bioaccessibility was observed suggesting that REE source is an important parameter influencing dissolution in biological fluids which may impact on human health exposure via the inhalation pathway.

### **S03.04.29. Platinum Group Elements, Lanthanoids and Other Metals of Concern in Road Dust and Airborne Particles in Houston, TX**

Ayse Bozlaker

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Abstract: Metal-content of inhalable fine particulate matter ( $PM_{2.5} \leq 2.5 \mu m$  in diameter) can increase the risk of adverse health outcomes while simultaneously providing clues to their origins. A unique aspect of Houston aerosols is their lanthanoid enrichment emanating from crude oil-cracking units in petroleum refineries with smaller contributions from oil combustion and shipping activities. Similarly, concentration pattern of platinum group of elements (PGE) used as unique markers of tailpipe emissions from light-duty vehicles is distorted from the crust in heavily trafficked areas, e.g., Texas. Evidence is also provided for transatlantic North African desert dust and its impact on mass and elemental composition of atmospheric aerosols during summers through detailed elemental analysis. Consequently, comprehensive characterization of airborne particulates for a wide range of elements will assist in identifying and apportioning various natural and anthropogenic sources. Our analytical method recently optimized for simultaneous measurement of three PGEs of Rh, Pd, and Pt, 14 lanthanoids, and numerous other trace- to major-elements will be briefly described in this presentation along with a summary of our measurements in source and receptor particulates in the greater Houston area. Our focus will be on road dust and airborne particulate matter, two important compartments of environmental PGEs, lanthanoids, and other anthropogenically polluted elements. Possible sources of primary particulate emissions and their contributions to  $PM_{2.5}$  mass concentrations in Houston air will also be summarized from source apportionment studies based on elementally characterized receptor data. Finally, compositional differences in ambient  $PM_{2.5}$  under the influence of different source emissions will be discussed using ternary diagrams and abundance pattern of lanthanoids.

### **S03.04.30. Platinum Group Element Enrichment in Road Dust and Their Human Bioaccessibility**

Clare Wiseman

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Abstract: Road dust is enriched with a range of metals and metalloids of human health concern, including technology-critical elements, such as the automotive exhaust catalysts platinum (Pt), palladium (Pd) and rhodium (Rh). To date, inhalable road dust particle size fractions have not been fully characterized in terms of their elemental composition or bioaccessibility upon uptake in the human lung. The goal of this study was to examine platinum group element (PGE) enrichment patterns and bioaccessibility in road dust particle size fractions of physiological relevance for human respiratory exposures (<10 microns). Inhalable particle size and bulk road dust samples (n=65) were collected in cooperation with the City of Toronto. Total (bulk) PGE concentrations were measured in dust samples using NiS fire-assay-INAA. The lung simulant, Gamble's solution, was used to extract the bioaccessible fractions of PGE (n=16). Metal concentrations were measured in extracts with ICP-MS. Using a laser diffraction particle size analyzer, the bulk of particles (50th percentile) in isolated inhalable sweeps had a measured diameter ranging between 6.5 and 14.6 microns. Pd occurred at the highest relative geometric concentrations in inhalable fractions of road dust (152 µg/kg), followed by Pt (geomean: 55 µg/kg) and Rh (geomean: 21 µg/kg). Iridium (Ir) was also detected in inhalable road dust fractions (geomean: 0.23 µg/kg). PGE concentrations were highest in the inhalable particle size fractions of road dust relative to bulk samples, with enrichment ratios that ranged from a low of 2.5 for Pd to a high of 7 for Ir. Pt was the most soluble in Gamble's solution (geomean: 16%), while Rh and Pd had geomean soluble fractions of 14% and 3.4%, respectively. Although PGE are used as catalysts in an elemental form, the study demonstrates that PGE in road dust are bioaccessible in the human lung.

S03.04G. The NIH Prisms Program: Informatics Systems for Pediatric Asthma Research with Integrated Sensor-Based Exposure, Context and Health Monitoring

**S03.04.31. Monitoring Particulate, PAH, Allergen and Microbial Exposures in Asthmatic Kids**

Steven Chillrud

*Steven Chillrud<sup>1</sup>, Jeff Blair<sup>2</sup>, Beizhan Yan<sup>1</sup>, Qiang Yang<sup>1</sup>, James Ross<sup>1</sup>, Masha Pitiranggon<sup>1</sup>, Luis M. Acosta<sup>3</sup>, Adnan Divjan<sup>3</sup>, Matthew Perzanowski<sup>3</sup>*

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Abstract: The overall goal of the PRISMS Program is to develop sensor-based measurement and informatics platforms of environmental, physiological, and behavioral factors for epidemiological studies of asthma, and eventually other chronic diseases, in the pediatric population. As part of PRIMSS, Columbia and AethLabs are developing and evaluating a modular array of miniaturized air monitors for use as personal and residential sensors for testing hypotheses on asthma development and asthma exacerbation. Our overall approach is to develop flexible monitors that can be used for different study designs and provide archive samples that can be stored for future hypothesis testing. Our real-time monitors measure spatial and temporal variations of potential acute asthma stressors (black carbon, UV-active particulate matter from sources such as environmental tobacco smoke, wood smoke or incense, particle reactive PAHs, relative humidity and temperature). The residential monitor can also integrate 3rd party commercial sensors for estimating fine and coarse particulate matter mass. In addition, we have built an archive monitor prototype that can collect two integrated samples that are either spatially- or time- resolved, and can be archived for subsequent lab analysis. Tri-axial accelerometer and GPS chips are integrated into our personal monitors allowing determinations of location, wearing compliance and activity related parameters. Data is transmitted to the PRISMS platform for storage and analytics. Progress has been made in developing a suite of asthma-related exposure measurements for archived integrated samples including PM2.5 and PM10 mass, volatile and semi-volatile organic compounds, and particulate-bound elements. We are validating filters for collecting integrated samples for analyses of airborne allergens (mouse, dust mite and cockroach) and PCR based microbial assays; preliminary results shows that the 2 hour of subway sampling provided enough mass for these bioassays.

### **S03.04.32. Clouded-Based Wearable and Stationary Sensors for Monitoring Air Pollution Exposure in Pediatric Asthma Research**

Zhenyu Li

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**Abstract:** Asthma is a common chronic disease of the airways, which affects 26 million people and costs \$56 billion each year in the US alone [1]. In particular, 7 million children suffer from asthma which causes more than 10 million lost school days due to asthma exacerbations. Although triggers to pediatric asthma exacerbations are well recognized such as airway infections, allergens, tobacco smoke, air pollution, and exercises, how the interactions between the environmental factors and the patients' biological and behavioral characteristics determine the susceptibility to and timing of such events is not well understood. One significant barrier to the causal understanding is the lack of objective measures on exposure metrics correlated with patient physiological responses and activities. Therefore, there is a significant unmet need to develop integrated sensor monitoring systems that can be deployed in a child's daily life to collect real-life exposure, context and health data for epidemiological studies of asthma. As part of the NIH PRISMS program, we have developed a wearable aldehyde sensor and a stationary Ozone and NO<sub>2</sub> monitor for pediatric asthma epidemiological research. The stationary sensor also includes a single-board computer with WiFi and Bluetooth Low Energy (BLE) capabilities, which can function as a gateway to a cloud-based informatics system for data storage, management and analytics. Here we will describe the design, manufacture, test, calibration and deployment of these sensors in a pilot clinical study. The sensor performances in the lab including sensitivity, dynamic range, linearity, drift, and temperature and humidity dependence will be presented. Integration of the sensors with a cloud-based PRISMS informatics system through the gateway will also be presented. Future work and potential applications to other diseases affected by environmental exposure will be discussed. [1] CDC. Asthma Facts - CDC's National Asthma Control Program Grantees. 2013.

### **S03.04.33. Development and Evaluation of the TEMU Personal Exposure Monitor for a Rural Children's Asthma Intervention Study**

Edmund Seto

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Abstract: Managing pediatric asthma in low-income populations living in rural agricultural communities is challenging for many reasons, including unique sources of indoor and outdoor air pollution that may trigger symptom exacerbations. Data from these settings are few. As a member of the NIH PRISMS consortium, we designed and explored the feasibility of a new exposure monitoring system called the TEMU for the Home Air in Agriculture Pediatric Intervention (HAPI) study in which low-income Latino children with asthma receive household HEPA air filtration units in a randomized intervention in rural Yakima, WA. During Winter 2017-18 season, a subset of 6 children from the HAPI study were recruited to use the TEMU system - a combination of a household indoor real-time particle monitor, a wearable personal real-time particle monitor, and a wireless tablet-based daily symptom diary. We observed good compliance and acceptance of the wearable monitor for most participants, however 2 participants chose to stop using the system after the first day. For those that successfully used the system, geocoded particle concentration data from the wearable monitor illustrated exposure differences between home, school and other community locations. Generally, household indoor particle monitoring data were correlated with personal exposures when children were at home, but were different when children were not at home. Particles collected both from the children's personal and household monitors will be archived for future analyses that may indicate the predominant sources of airborne particle exposures in this setting.

### **S03.04.34. Scaling Up Data Integration and Analysis of Sensor Data for Pediatric Asthma**

Jose Luis Ambite

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**Abstract:** Childhood asthma is a serious chronic disease affecting 9.3 percent of the American pediatric population. Current epidemiological research tools are limited in the types of information they can collect and aggregate, which restricts their predictive power. The NIH Pediatric Research using Integrated Sensor Monitoring Systems (PRISMS) program is predicated on the idea that better, more accurate sensing of physiology, environmental exposures, and local context can greatly enhance scientific and clinical understanding towards more effective management of chronic disease. At the PRISMS Data and Software Coordination and Integration Center (DSCIC), we are developing a general data integration and analysis architecture, building upon Apache Kafka and Apache Spark, with several advantages. First, our system enables biomedical researchers to (1) collect streaming data from multiple sensors, including at-home and personal pollution monitors, environmental and weather sources, geospatial features and personal trajectories, and Ecological Momentary Assessments (EMA) data collected from subjects' mobile phones; (2) map these heterogeneous datasets to a common schema to facilitate analysis; and (3) train and apply statistical models over both streaming and historical data at scale. Our target applications include prediction algorithms for asthma exacerbations, identifying key personal-level triggers, and eventually providing closed-loop interventions. We will present an overview of the PRISMS-DSCIC data integration and analysis architecture, demonstrate a statistical analysis use case, and describe how our architecture enabled the development of a novel data mining approach using publicly available spatial data (OpenStreetMap) and meteorological data (Dark Sky) to build an air quality model for predicting the concentration of PM<sub>2.5</sub> at a fine spatiotemporal resolution.

## S03.04H. Women at Work: How Exposed Are They?

### S03.04.36. Sex Differences in Occupational Risks in Ontario Workers

Paul Demers

*Paul A. Demers<sup>1</sup>, Jill MacLeod<sup>1</sup>, James K. Jung<sup>2</sup>, Chloe Logar-Henderson<sup>1</sup>, Sharara Shakik<sup>1</sup>, Jeavana Sritharan<sup>1</sup>, Victoria Arrandale<sup>1</sup>, Chris McLeod<sup>3</sup>*

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**Abstract:** Introduction When examining the risk of occupational disease, it is common to identify discordant results by sex. While these differences may be due to chance or non-occupational factors, they may also represent unidentified differences in occupational risk. Here we illustrate the challenges of interpreting discordant results by sex using the lung cancer results from the Occupational Disease Surveillance System (ODSS). Methods The ODSS uses a cohort of 2,190,246 Ontario workers (34% female) to examine occupational risks for lung cancer. The cohort was created by linking data from the workers compensation system (1983-2016) with Ontario tumour registry and other health data. Cox-proportionate hazard models were used to calculate sex-stratified age-adjusted hazard ratios (HR) and 95% confidence intervals (CI). Results There were 25,469 lung cancer cases among men and 9,192 among women. Using broad industry groups (10 categories) statistically significant ( $p < 0.05$ ) elevated results for men in mining, construction, transportation, and finance and for women in wholesale and retail trade. Using broad occupational groups (22 categories), the significant results for men and women were congruent for blue-collar categories, though the HRs were consistently higher in women versus men. For example, the HRs for machining jobs were 1.09 (CI=1.03-1.13) for men and 1.32 (CI=1.15-1.51) for women, and HRs for transportation equipment operating were 1.38 (CI=1.32-1.45) for men and 1.52 (CI=1.26-1.82) for women. In contrast, women had increased HRs in clerical (1.19, CI=1.10-1.28), sales (1.21, CI=1.10-1.32), and service occupations (1.11, CI=1.04-1.18), which were not observed among men. Conclusions Industry results were largely discrepant, while occupational results were similar for blue-collar groups with potential exposure to established carcinogens. Some elevated risks could be due to non-occupational factors (e.g. smoking), but others may be due to unrecognized hazards.

### **S03.04.37. Sex Differences in Occupational Physical Activity**

Vikki Ho

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Abstract: Strong evidence supports that participation in recreational physical activity (PA) is beneficial for health. However, PA is also derived from occupational, household and transportation-related activities, among which perhaps the most important is occupational, due to the time spent at work and that some jobs entail considerable PA. In contrast to recreational PA, the effects of occupational PA have been studied to a much lesser extent. Though, energy expenditure regardless of its source should have similar beneficial effects, certain jobs are conducted in settings that may contain hazardous exposures, whereby increasing occupational PA may actually exacerbate harmful effects. As sex differences may affect activity levels and/or the metabolism of certain chemical exposures, research should incorporate the consideration of sex and gender. We examined sex differences in occupational PA levels using data from a population-based case-control study of lung cancer conducted in Montreal, Canada (889 men, 564 women). In this study, lifetime job history was collected via in-person interviews; for each job, the main tasks conducted were also obtained. The energy expenditure for each job-related task, in units of metabolic equivalent of task (MET), was determined via expert assessment by an industrial hygienist and an exercise physiologist. In preliminary analysis, the most common jobs held by men and women included accountant, occupations related to management and administration, clerk, cleaner and waiter. Despite these occupations being mostly white collar, MET values were found to be higher in men than in women (t-test  $p < 0.05$  for: sales clerk, cleaner and hand packager). Further analysis will be conducted to compare the job profiles, based on job titles, industries and tasks, by sex. Less is known about occupational determinants of health in women than men, and understanding sex differences in occupational energy expenditure is one avenue to inform on prevention efforts.

### **S03.04.38. Occupational Exposures among Women Based on CAREX Canada's Estimates**

Cheryl Peters

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**Abstract:** Introduction CAREX Canada develops estimates of the prevalence of exposure to carcinogens. This data can be shown by sex, but potential sex-differences in prevalence of exposure were not considered. The objective of this work is to a) highlight workforce differences by sex, and b) to identify industries/occupations where women's exposures may be underrepresented in CAREX Canada estimates. Methods Census data were obtained from Statistics Canada for 2006 and 2016. Comparisons of prevalence by sex were done by industry and occupation, as well as between these 2 time points to identify categories predominantly composed of female (or male) workers. Exposure prevalence estimates were compared by sex, and broad trends in carcinogen exposure prevalence between female and male workers were calculated. Results The 2006 workforce was 47.3% female, and this increased slightly in 2016 (47.8%). However, stark differences occur in some industries; for example, health care was strongly female-dominated (82.1% female in 2006 and 2016), and construction was strongly male-dominated (12% female in 2006 and 2016). Nearly all industries were stable ( $\leq 2\%$  change) in terms of sex balance over the census periods. CAREX estimates indicate that men strongly dominate the carcinogen-exposed workforce in Canada, with 81% of the exposures (on average), reflecting occupational categories where 'traditional' carcinogens are well-known to occur (such as construction, mining, and manufacturing). An emerging exposure where this was not the case was antineoplastic drug exposures, which are dominated by female workers (75% of those exposed). Conclusions CAREX estimates may give a false impression that exposure to carcinogens is less important in females than males due to our better knowledge of exposure patterns in male-dominated industries and its focus on the more "traditional" carcinogens.

### **S03.04.39. Occupational Exposures among Nail Technicians in Toronto, Canada**

Victoria Arrandale

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**Abstract:** Introduction: Nail salons have proliferated recently. In Toronto, Canada, many of these salons are small businesses that employ immigrant women. The Healthy Nail Salon Network has undertaken initiatives to better understand the work and health of nail technicians in Toronto, ON. We present preliminary results of a study of chemical, ergonomic and psychosocial hazards in Toronto nail salons. Methods: Sampling has been completed in five salons. Personal air samples were collected in the workers' breathing zone to assess for exposure to VOCs, phthalates, organophosphate esters. Stationary continuous monitors were also used to assess formaldehyde and particulates in the work environment. The Quick Exposure checklist (QEC) was completed to assess the ergonomic risk associated with common nail salon tasks, and the Karasek job control demand scale was used to investigate job strain. Results: In total, 10 workers participated in the sampling. Overall, 16 of the 20 VOCs investigated were detected. Acetone, ethyl acetate, methyl methacrylate, n-butyl acetate and toluene were detected in all samples. Formaldehyde (personal) exposures ranged from 16.5ppb to 39.6ppb (AM 24.2ppb). Methyl methacrylate ranged from 0.40mg/m<sup>3</sup> to >18mg/m<sup>3</sup> (AM 3.9 mg/m<sup>3</sup>). Plasticizers were also identified in air: 8 phthalates and 6 organophosphate esters were detected in at least one sample. For manicure and pedicure tasks, the QEC results showed high or very high back (static) and neck ergonomic exposures; shoulder and wrist/hand exposures were low/moderate. Results from the Karasek scale placed 83% of participants in the high job strain domain (low decision latitude and high job demands). Conclusions: These preliminary results indicate that nail technicians have a variety of potentially hazardous exposures, not limited to chemicals. Further results from 26 enrolled salons will provide a more complete picture of these exposures among nail technicians in Toronto, Canada.

### **S03.04.40. Women at Work: How Exposed Are They?**

Mieke Koehoorn

*Mieke Koehoorn<sup>1</sup>, Esther Maas<sup>1</sup>, Andrea Jones<sup>1</sup>*

*1. School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada.*

**Abstract:** Aim: To use workers' compensation claims for occupational disease and illness over a 25-year period as an indicator for women's exposures at work. Methods: Accepted compensation claims and labour force statistics for workers in the Canadian province of British Columbia were used to calculate annual rates of occupational disease and illness for women compared to men from 1992 to 2016. Results: Over 86,000 compensation claims for occupational disease and illness were accepted during the study period, but 7% were missing data on gender. Infectious disease rates increased over time and were always higher for women than men (29 versus 4 cases per 100,000 in the last five years of follow-up). Hearing loss rates decreased over time and were always higher for men than women (24 versus 1 case per 100,000 in the last five years). Skin condition rates decreased over time and were similar for men and women (3 cases per 100,000 men and women in the last five years). Mental disorder rates increased over time but more so for women than men (from 9 cases per 100,000 in the first five years of follow-up for both men and women to 19 cases for men and 26 cases for women in the last five years). Small cell sizes (<5 cases annually) for cardiovascular and respiratory diseases and for neoplasms precluded rate calculations for women. Small cell sizes were also an issue for environmental exposures but, where comparisons were feasible, men always had higher rates than women. Discussion: Women were more likely to have claims related to infectious and mental stress exposures, while men were more likely to have claims related to environmental and noise exposures. An exception was skin conditions (dermatitis) with similar rates for men and women over time. Despite significant shifts in labour force participation by women, claims rates for occupational conditions remain highly gendered. Next steps include stratification of disease and illness rates by occupation.

Thursday, August 30

O04.01A. Simulation, Scenario, and Policy Modeling of Air Pollution Emissions and Health

**O04.01.01. A Proof-Of-Concept Approach for Quantifying Multipollutant Health Impacts Using Joint Effects Models within the Open-Source BenMAP-CE Software Program**

Jason Sacks

*Jason Sacks<sup>1</sup>, Evan Coffman<sup>1</sup>, Ana G. Rappold<sup>1</sup>, Jim Anderton<sup>2</sup>, Meredith Amend<sup>2</sup>, Kirk Baker<sup>1</sup>, Neal Fann<sup>1</sup>*

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Abstract: Air pollution risk assessments often use results from epidemiologic studies to quantify health impacts of air quality changes to individual pollutants, but tend not to account for exposure to complex mixtures. Multipollutant statistical models consider collinearity among pollutants by identifying mixtures commonly emitted from specific sources. Using a proof-of-concept version of the environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE) we aim to answer: (1) can the results from multipollutant statistical models (joint effect models) be used in air pollution risk assessments?; (2) how does the procedure for quantifying population health impacts differ between a single and multipollutant context? We identified studies using joint effect models with/without interactions to estimate the risk of air pollutant-attributable asthma emergency department (ED) visits. These studies examine associations between short-term criteria pollutant exposures (O<sub>3</sub>, PM<sub>2.5</sub>, CO, NO<sub>2</sub>, SO<sub>2</sub>) and PM components, which represent predefined source groupings (oxidant gases, secondary pollutants, traffic, power plant, criteria pollutants). We use results from these studies and daily air quality data in BenMAP-CE for a case study in the city of Atlanta and the state of Georgia. Preliminary results indicate: (1) interaction models yield larger estimates of pollutant-attributable asthma ED visits; (2) warm season impacts are greater than cold season; and (3) certain pollutant groups yield a negative number of cases. BenMAP-CE runtime for multipollutant models was commensurate with runtime for single pollutant models. This study suggests that risk assessments for multipollutant exposures are feasible, but data-intensive. Future risk assessments using single and multipollutant approaches can potentially provide a more comprehensive evaluation to inform air quality management strategies. Disclaimer: The views expressed do not necessarily reflect the views/policies of U.S. EPA.

## **O04.01.02. Regional Assessment of Current and Future States of GHGs Emissions: Impacts of Transportation Policy Scenarios**

Maryam Shekarrizfard

*Maryam Shekarrizfard<sup>1</sup>, Naveen Eluru<sup>2</sup>, Audrey Smargiassi<sup>3</sup>, Patrick Morency<sup>4</sup>, Louis-Francois Tetreault<sup>4</sup>, Celine Plante<sup>4</sup>, Sophie Goudreau<sup>4</sup>, Louis Drouin<sup>4</sup>, Shamsunnahar Yasmin<sup>2</sup>, Nowreen Keya<sup>2</sup>, Tanmoy Bhowmik<sup>2</sup>, Marianne Hatzopoulou<sup>1</sup>*

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Abstract: Estimating the future state of greenhouse gases (GHGs) and air quality associated with transportation policies and infrastructure investments is key to the development of meaningful transportation and planning decisions. This study describes the design and application of an integrated transportation emission model for the prediction of GHGS in CO<sub>2</sub>eq in the Greater Montreal Region as a result of transport policy scenarios and Land use scenarios. For this purpose, a travel demand model linked with models for traffic assignment and emissions, was used to simulate GHG emissions in a base year (2008) and a horizon year (2031) while incorporating population and demographic projections. Various stakeholders were consulted in the development of future scenarios affecting land-use and transportation through a web-based survey and workshop. In the 2031 business as usual scenario, an average decrease of 30% in GHG emissions was estimated compared to the 2008 base case. This decrease is primarily attributed to projected improvements in vehicle technology. The modelling system was used to evaluate the impact of a 20% market penetration in electric vehicles, revealing significant reductions in GHG emissions across the region. Work is currently underway to estimate the emissions of nitrogen oxides (NO<sub>x</sub>) and NO<sub>2</sub> concentrations to assess air quality and individuals' daily exposure by tracking activity locations and trajectories of the population and observe the level of reduction in daily exposures compared to the base case. This study is funded by a collaborative grant from the Canadian Institutes of Health Research (CIHR) and the Natural Sciences and Engineering Research Council of Canada (NSERC) and Ouranos.

### **O04.01.03. Estimation of the Effect of Hypothetical Air Pollution Scenarios on Lung Function in the Southern California Children's Health Study: An Application of G-Computation**

Robert Urman

*Robert Urman<sup>1</sup>, Erika Garcia<sup>1</sup>, Kiros Berhane<sup>1</sup>, Rob McConnell<sup>1</sup>, Frank Gilliland<sup>1</sup>*

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**Abstract:** Background: We have shown improved lung function with decreasing pollutant levels across several cohorts from the Southern Californian Children's Health Study (CHS). In this study, we estimate the benefits of air pollution reduction on lung function growth under several hypothetical scenarios by implementing g-computation, a method based in the counterfactual framework. Methods: Forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) were assessed repeatedly among 2120 adolescents across 3 CHS cohorts spanning nearly 2 decades. Averages of regional nitrogen dioxide (NO<sub>2</sub>) and particulate matter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) were taken from 1994-1998, 1997-2001, and 2007-2011, which correspond to lung growth from 11 to 15 years of age in these cohorts. Mixed-effects linear regression models, incorporating regional pollutants and key covariates, were used to model growth trajectory for each lung function measure from age 11 to 15. Compared to lung function growth based on observed data, we estimated the difference in growth had levels of NO<sub>2</sub> and PM<sub>2.5</sub> either 1) remained at the average concentration observed in 1994-1998 or 2) met one of several existing or hypothetical air quality standards (air pollution lowered only in communities exceeding the standard). Bootstrap samples (N=1000) were used to calculate confidence intervals. Results: FEV1 growth was estimated to have been reduced by 2.7% (95% CI: -3.6%, -1.8%) had NO<sub>2</sub> remained at 1994-1998 levels. Implementing standards of 30, 20, and 10 ppb for NO<sub>2</sub> were estimated to increase FEV1 growth by 1%, 3.9%, and 9.1%, respectively. Remaining at 1994-1998 levels for PM<sub>2.5</sub> was estimated to decrease FEV1 growth by 2.6%, while increases of 2.6%, 3.6%, and 4.4% were estimated had concentrations been lowered to 15, 12, or 10  $\mu\text{g}/\text{m}^3$ , respectively. Larger pollution-associated changes were estimated for FVC. Conclusion: Lowering concentrations of NO<sub>2</sub> and PM<sub>2.5</sub> would have likely resulted in better lung function in our population.

#### **O04.01.04. Quantifying Health Benefits of Coal Power Plant Phase-Out in Canada and the U.S.: An Adjoint Sensitivity Analysis**

Amir Hakami

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Abstract: We estimate monetized health benefits of phasing out the coal-fired power plants in Ontario and Alberta as well as in the US. We quantify these health impacts by accounting for reduced mortality due to chronic exposure to NO<sub>2</sub> (In Canada) and PM<sub>2.5</sub> (In Canada and the US). We apply the US EPA's Community Multi-Scale Air Quality (CMAQ-5.0) model and its adjoint to quantify the marginal benefits (MB) of NO<sub>x</sub> and PM<sub>2.5</sub> emissions. The adjoint model traces mortality counts back to emissions for each single source location and time. The backward simulations of the model rely on non-linear concentration-response (C-R) functions of single (PM<sub>2.5</sub>) and three-pollutant (PM<sub>2.5</sub>, NO<sub>2</sub> and O<sub>3</sub>) epidemiologic models. The simulations are done over a nested 12 km and 36 km domain, covering North America and for July 2010. Our preliminary results show health benefits for specific plants in Ontario and Alberta are between C\$ 30k-310k/ton of PM<sub>2.5</sub> and \$30-270k/ton of NO<sub>x</sub>. These values range between \$30k-580k/ton of PM<sub>2.5</sub> for plants in the US. Retrospective analysis of coal phase-out in Ontario suggests benefits of \$3.1 billion/yr, while societal benefits of the proposed phase-out in Alberta is approximated at \$2.4 billion/yr. We find significant benefits from coal phase-out in both Ontario and Alberta, and even larger benefits in the US. For Ontario, our results suggest that most of the health benefits from Ontario coal phase-out materializes in the province, whereas Alberta phase-out entails larger out-of-province benefits.

#### **O04.01.05. Application of Different Concentration-Response Functions to Estimate the Societal Benefits of Reducing PM2.5 and NOx Emissions**

Amanda Pappin

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**Abstract:** Objective: We assess the societal benefits of reducing air pollutant emissions that contribute to ambient fine particulate matter (PM<sub>2.5</sub>), ozone (O<sub>3</sub>), and nitrogen dioxide (NO<sub>2</sub>) exposure and public health impacts. Recent evidence suggests that nonlinear, multi-pollutant concentration-response (C-R) models are more appropriate than traditional, linear forms used in epidemiology. We examine the implications of alternate C-R models in an emissions reduction framework. Methods: We integrate C-R models for non-accidental mortality due to PM<sub>2.5</sub>, O<sub>3</sub>, and NO<sub>2</sub> into the Community Multiscale Air Quality Model (CMAQ). This sophisticated atmospheric model and its adjoint tool allow us to trace public health impacts back to sources of pollutant emissions. We compare the monetized public health benefits of reducing emissions from sources across Central Canada at a 12 km resolution for July 2010. We apply C-R models (single or multipollutant and linear or nonlinear) derived from the 2001 Canadian Census Health and Environment Cohort (CanCHEC). Results: Our preliminary results indicate significant and widespread benefits of PM<sub>2.5</sub> and NO<sub>x</sub> (NO + NO<sub>2</sub>) emissions control, particularly in major urban areas of Central Canada. We find benefits ranging from \$400,000-800,000 per ton of reduction in PM<sub>2.5</sub> from sources in Toronto, while NO<sub>x</sub> control for the same location entails benefits of \$2,000-200,000/ton depending on the choice of C-R model. Nonlinear models consistently produce larger benefit estimates than their linear counterparts. We estimate coefficients of variation based solely on the choice of C-R model to be 0.4-0.6 for PM<sub>2.5</sub> and 0.6-1.6 for NO<sub>x</sub>. Conclusions: Our results show that the public health benefits of emission reductions are highly sensitive to C-R specification, and that

traditional C-R models may significantly underestimate the benefits of air pollution controls. Further research is needed to determine the most appropriate C-R model to support public policy.

#### **O04.01.06. A Model of Ischaemic Heart Disease in the UK that Suggests Reductions in Air Pollution Increase Overall Disease Prevalence**

Paul Wilkinson

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**Abstract:** Objectives We have previously used a simple toy model to suggest that the proportion of people with ever-diagnosed ischaemic heart disease (IHD) from air pollution is heavily influenced by the effect of air pollution on case fatality as well as on disease incidence, and that this effect may lead to counter-intuitive changes on disease prevalence. We now report the results of a microsimulation model for the UK that provides more formal quantification of air pollution-related IHD morbidity burdens. Methods The model was based on a three health-state model of disease progression ('disease free', prevalent disease, death), initialized using current incidence and disease prevalence data for the UK, and using literature-based estimates of state transition probabilities and the relative risks (RRs) for disease incidence, case fatality and mortality. We examined the impact over 106 years (to extinction of the current birth cohort) of removal of all ambient PM2.5 of anthropogenic origin. Results The model indicated that for all primary outcomes (disease incidence, prevalence, and mortality) removal of anthropogenic PM2.5 would lead reductions in the absolute number of cases at young ages but appreciably increased numbers at older age-groups, reflecting improved survival and the expansion of the population at older ages. After a 106-year simulation there was a 7% net increase in the number of cases of people with ever-diagnosed ischaemic heart disease. Conclusions This modelling confirms more nuanced patterns of the impact of air pollution on IHD morbidity than those suggested by studies based on disease incidence alone. It suggests counterintuitive effects, which may increase prevalence following reduction of PM2.5 air pollution as a consequence of effects on survival. Reductions in air pollution may not therefore reduce health service costs for IHD treatment as commonly assumed.

## 004.01B. Climate and Temperature Effects

### **004.01.07. An Integrated Approach to the Development of Health-Related Climate Change Indicators for Australia**

Maryam Navi

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**Abstract:** Introduction: Australia has experienced, and is projected to experience, a range of climate-related health impacts. However, there are limited tools to track the health impacts of climate change and to develop public health interventions in a timely manner. The purpose of this study was, therefore, to develop climate health indicators and to address feasibility of the indicators for Australian Stakeholders, using South Australia as a case study. Methods: due to the multidisciplinary aspects of climate-related health outcomes, a parallel mixed methods approach was adopted. The methodology included quantitative case studies focusing on spatio-temporal aspects of climate and health, and a qualitative case study for exploring stakeholder perspectives on indicator development. Results: Analysis of the relationship between heatwaves and ambulance callouts showed that Adelaide's western, inner and northern suburbs had a higher incidence rate ratio (IRR) during heatwaves compared to non-heatwaves (highest IRR of 1.26). Suburbs clustered in central Adelaide had a higher risk of emergency department visits (highest IRR of 1.41) and hospital admissions (highest IRR of 1.72). Analysis of the above-mentioned health outcomes and a range of vulnerability risk factors found four main risk factors; living alone, needing assistance with core activities, being aged above 65, and being socio-economically disadvantaged. Qualitative findings revealed a high level of stakeholder awareness of the climate-health impacts, and the need for indicators that can inform policymakers regarding interventions. They also raised several issues including lack of resources and access to data. Conclusions: The analysis has yielded an insight into vulnerable areas to heat-health effects in metropolitan Adelaide at local level. The evidence has important implications for public health planners to consider population vulnerability to climate change and use this information for policy and intervention.

#### **O04.01.08. Building Vulnerability in a Changing Climate: Using Sensors to Track Environmental Conditions and Health Outcomes during a Heatwave in Low-Income Older Adults**

Augusta Williams

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Abstract: Human vulnerability to HWs arises from many risk factors (i.e. age, social isolation, low income, low education, minority status, non-English speaking, etc.). Older adults in particular are extremely vulnerable to extreme heat exposures. High prevalence of pre-existing disease, medications, and autonomic nervous system impairments affect the thermoregulation and perception of extreme temperature exposure, making them more susceptible to poor health outcomes during HWs. Extreme temperatures may be mitigated or exacerbated indoors compared to outdoor temperatures during HW events due to building archetype and air conditioning (AC) use. In the present study, we aimed to characterize the indoor environmental quality and relate it to health outcomes through the use of personal, indoor monitoring with 51 (central AC, n=24; non-central AC, n=27) low-income senior residents of affordable housing in Cambridge, MA during a HW event in 2015. Indoor environmental temperature, noise, and carbon dioxide were all significantly higher ( $p < 0.001$  for all) for the non-central AC building when compared to the central AC building. Within the non-central AC building, there was a 36% increase in the mean of all self-reported health symptoms during the HW event compared to the central AC building ( $p = 0.013$ ). The mean number of heat-related health symptoms was 72% higher for those in non-central AC than for central AC residents during the HW ( $p = 0.0013$ ), despite similar age, income, and prevalence of pre-existing conditions between building types. Capturing a more representative description of the temperature exposure, while also incorporating changing behavioral modifications and other important environmental features that compound the effects of heat exposure in real life settings, we gain a more comprehensive understanding of the complex impact of HWs on health and drivers of vulnerability to heat exposure.

#### **O04.01.09. Emergency Preparedness in Mi'kmaw Communities in Nova Scotia**

Amber MacLean-Hawes

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Abstract: Climate change is expected to disproportionately affect First Nations communities due to their reliance on the environment, economic situations and geographic locations. The Climate Action program, which is part of the Confederacy of Mainland Mi'kmaq's Department of Environment and Natural Resources has been working with Mi'kmaw communities in Nova Scotia to identify climate change vulnerabilities. Throughout this process, band officials and knowledge holders from each community have been engaged in conversation to discuss the impacts of climate change on their community. Representatives from each First Nation have identified and expressed concern for climate change impacts that pose a direct threat to the health and safety of their community members, and in each case have identified Emergency Response Planning as a key vulnerability to climate change in each participating community. Through funding provided by the Department of Indigenous Services Canada, Climate Action is working to provide the information necessary to develop up to date emergency management plans that are proactive; taking predicted climate changes into consideration and providing protocols and resources necessary to effectively respond to and manage emergencies according to community needs using a holistic approach.

#### **O04.01.10. Spatial Patterns of Heat Vulnerability Constituents across Massachusetts**

Leila Heidari

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**Abstract:** To address the health threat posed by increasing temperatures, it is necessary to understand where those most vulnerable to heat are located. While an overall heat vulnerability index (HVI) can identify which areas experience the composite burden of vulnerability, we elucidate which component factors drive heterogeneity in heat vulnerability across the state of Massachusetts. We constructed a Massachusetts HVI based on the HVI developed for New York State which includes factors describing 4 vulnerability dimensions: social/language; socioeconomic; environmental/urban; and elderly/social isolation. We calculated the individual HVI components for Massachusetts at the census tract level using data from the American Community Survey and National Land Cover Database at two time points, 2006 and 2011. Higher concentrations in urban areas were seen for housing density and social/language factors (race/ethnicity, non-English speaking), with lower concentrations (<10% of the population in a census tract) having the social/language vulnerability factor for the majority of the state. Poverty showed a heterogeneous pattern across the state, with elevated concentrations in both urban and rural areas. Elderly and some socioeconomic factors (disability, unemployed, and older homes) showed high concentrations not only in urban census tracts, but distributed across the state. Changes in spatial distributions of vulnerability factors between 2006 and 2011, were observed in regard to increases in older homes and unemployment, while highly developed area increased by 4.57%. HVI is multifactorial and the individual contributing factors can differentially vary across large geographical areas. Understanding the individual components of HVI can help us identify necessary sociodemographic, land use, and housing targets for statewide heat vulnerability interventions.

#### **O04.01.11. Air Conditioning and Heat-Related Mortality in U.S. and Japan: A Longitudinal Analysis**

Francesco Sera

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**Abstract:** Background and aim: Several studies have provided evidence of a decrease in susceptibility to heat in the last decades, but the factors responsible for such attenuation are unclear. Some have investigated the role of air conditioning (AC), with conflicting results. In this contribution, we use a novel two-stage longitudinal design and a multi-country multi-city database to assess the association between changes in air conditioning prevalence and reduction of the heat-related risks. Methods: We collected daily time series of temperature and mortality, and yearly AC prevalence, for 47 prefectures in Japan (1974-2009) and 48 cities in USA (1985-2006). In the first stage, we fitted quasi-Poisson regressions with distributed lag non-linear models for temperature (lag 10 days), repeatedly over defined windows (6 years for Japan and 4 years for US). In the second-stage, we used a novel multilevel multivariate random-effects meta-regression model to evaluate longitudinally the effect modification of AC prevalence on the derived set of splines coefficients, with multiple measures over time repeated within location. Results: In both countries, we observe an attenuation of heat-related mortality that is significantly associated with increase in AC prevalence (Japan  $p=0.028$ , USA  $p<0.001$ ), on top of an independent underlying trend ( $p<0.001$ ). For example, the relative risk for the 99th vs minimum percentile decreases from 1.114 (95% CI 1.110; 1.129) to 1.102 (1.091; 1.115) in Japan, and from 1.100 (1.081; 1.119) to 1.067 (1.048; 1.086) in USA, predicted for AC prevalence equal to 40% and 70%, respectively. Conclusions: By applying a novel longitudinal two-stage design and flexible meta-analytical models, we observed that populations became more resilient to heat over time in both Japan and US, and that this trend seems partially attributable to increase in AC use. In the next steps we will extend the analysis to evaluate the possible confounding role of time-varying covariates,

## **O04.01.12. Population Adaptation Phenomena Modelled through Functional Regression**

Pierre Masselot

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Abstract: The majority of weather-related health studies use past data in regression models to model the relationship between a weather exposure and a health issue. A large variety of models have been used over the years for this purpose, progressively increasing their complexity and relevance. However, gaps still exist in the understanding of weather/health relationships which, when filled, would help predicting more accurately the impact of climate change on human health. In this purpose, the present paper introduces functional regression models for environmental epidemiology studies. These models consider continuous curves instead of series of scalar values as input and/or output. Functional models are thus flexible and able to take advantage of the whole information contained in the data to estimate the weather/health relationship. Two types of functional regression models are applied in the present work to model temperature-related cardiovascular mortality in the city of Montreal, Canada. The first type of model seeks to estimate the impact of hourly temperature variations on cardiovascular mortality. The second one seeks to model how the studied relationship evolves during the year. Both applications allows new insights on the temperature/cardiovascular mortality relationship in Montreal. They especially suggest physiological adaptation effects in the response of the population to temperature, either during summer or winter. From this simple application, it is hoped that functional regression models will be used in more complex studies.

## 004.01C. Exposures and Effects in Communities

### **004.01.13. Exposure Measurement Pilot Study for Children and Adults Using Synthetic Turf Fields with Recycled Tire Crumb Rubber Infill**

Elizabeth Irvin-Barnwell

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Abstract: The U.S. Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds (FRAP) is a multi-agency research plan in response to concerns over the use of tire crumb rubber as infill on synthetic turf fields. The FRAP outlines specific research objectives, including characterizing tire crumb rubber and implementing a pilot-scale observational exposure characterization study. The exposure characterization study was a pilot-scale effort aimed at collecting information on how people might be exposed to chemicals in crumb rubber infill while playing on synthetic turf fields. We enrolled children and adults taking part in athletic activities on synthetic turf field in several locations to participate in questionnaire, exposure measurement, and video recording study elements. In the exposure measurement sub-study, several types of samples were collected. Next-to-field air samples were collected during the sports or training activity and dermal wipe samples were collected immediately following the activity. Collection of personal air VOC samples during the activity was attempted. Field wet wipe, drag sled, and dust samples were collected from each field. Air samples were analyzed for total suspended particulates, metals, VOCs, and SVOCs; dermal wipe samples, field wipe samples, and dust were analyzed for metals and SVOCs. Urine and blood samples were collected pre-activity and post-activity. Study recruitment and enrollment was initiated in August 2017. For the exposure characterization study, 32 athletes were enrolled, with ages ranging from 7-28. Of the 32 athletes, 25 participated in the exposure measurements sub-study; blood and urine specimens were collected from 13 and 14 participants, respectively. Additionally, 17 individuals participated in the videography component. This presentation will focus on the key results from the exposure measurements sub-study.

#### **O04.01.14. Air Pollution and Infectious Disease Burdens on Lung Function in the Eastern Caribbean**

Steve Whittaker

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Abstract: Increasing respiratory illnesses have been observed in urban centers due to diminished air quality. This study evaluated associations between urban air pollutants in the Eastern Caribbean nation of St. Kitts-Nevis during drought and lung function among residents previously at risk for chikungunya infection. Mean concentrations of nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>10</sub>), collated between 2015 and 2017, were used to derive district-specific exposure categories (lower, moderate, higher). Cross-sectional health and lifestyle surveys were performed in conjunction with spirometry tests for 241 residents, ages 15 to 75 years, in 2016 and 2017. While NO<sub>2</sub> had no significant impacts, moderate and higher PM<sub>10</sub> exposures were associated with increased FEV<sub>1</sub>/FVC deficit (<70%), OR=2.2 (95% CI: 1.13, 4.34; p= 0.020) and 3.17 (95% CI: 1.00, 10.02; p=0.049), respectively. Adjusting for air quality and other factors, chikungunya infection among persons living in the same district for more than 3 years was linked reduced FEV<sub>1</sub>/FVC (OR=2.44 95% CI: 1.20, 4.93; p=0.013). Results further evidence that air pollution concentrations below guidelines set by the World Health Organization are associated with adverse respiratory health effects and suggest, for the first time, that a vector-borne disease, chikungunya, can be explicitly associated with reduced lung function.

#### **O04.01.15. Attitude Towards Livestock Farming Does Not Influence Associations between Farm Proximity and Respiratory Health in a Rural Population Study**

Lidwien Smit

*Floor Borlée<sup>1</sup>, Joris Yzermans<sup>2</sup>, Floor Oostwegel<sup>1</sup>, Francois Schellevis<sup>2</sup>, Dick Heederik<sup>1</sup>, Lidwien Smit<sup>1</sup>*

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**Abstract:** Background: Several epidemiological studies have shown health effects of non-farming residents living in close proximity of livestock farms. Respondents' attitude towards farming may be a source of bias since concerns about environmental hazards may influence self-reported outcomes. The main aim was to assess whether earlier observed associations between proximity to farms and respiratory health effects were biased by participants' attitude towards farming. Methods: We developed an attitude score for the Dutch Livestock Farming and Neighbouring Residents' Health study population (n=2,457) by factor analysis of 13 questionnaire items related to attitudes towards livestock farming. Linear regression analysis was used to assess the association between attitude and potential determinants. The effect of attitude on associations between farm proximity and respiratory conditions was analysed by adding the attitude-score as a confounder in linear or logistic regression models. Interaction between farm exposure and the attitude-score was also tested. Results: In general, the study population had a positive attitude towards farming, in particular if participants were more familiar with farming. Older participants, females, ex-smokers, and individuals with a higher education had a more negative attitude. Both self-reported respiratory diseases and exposure to livestock farms were associated with a more negative attitude, which is a concern for our epidemiological study. Awareness bias might have played a role here, and attitude could potentially confound exposure-response relations. However, no indication was found that the associations between proximity to farms and respiratory health were confounded or modified by attitude. Conclusions: When studying self-reported data in environmental health studies, we recommend to measure attitude towards a potential hazard to study the impact of potential awareness bias.

#### **O04.01.16. Arsenic, One-Carbon Metabolism and Diabetes-Related Outcomes in the Strong Heart Family Study**

Miranda Spratlen

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**Abstract:** Inorganic arsenic exposure and inter-individual differences in its metabolism have been associated with cardiometabolic risk. A more efficient arsenic metabolism profile (lower MMA%, higher DMA%) has been associated with reduced risk for numerous adverse health outcomes but an increased risk for diabetes-related outcomes. The mechanism behind these contrasting associations is equivocal; we hypothesized one carbon metabolism (OCM) may play a role. We evaluated the association between OCM-related variables (nutrient intake and genetic variants) and both arsenic metabolism biomarkers (iAs%, MMA% and DMA%) and diabetes-related outcomes (metabolic syndrome, diabetes, HOMA2-IR and waist circumference) in 935 participants free of prevalent diabetes and metabolic syndrome from the Strong Heart Family Study, a family-based prospective cohort comprised of American Indian tribal members aged 14+ years. OCM nutrients were not associated with arsenic metabolism, however, higher vitamin B6 was associated with diabetes-related outcomes (higher HOMA2-IR and increased risk for diabetes and metabolic syndrome). A polymorphism in an OCM-related gene, methionine synthase (MTR), was associated with both higher MMA% ( $\beta=2.57$ , 95% CI: 0.22, 4.92) and lower HOMA2-IR (GMR=0.79, 95% CI=0.66, 0.93 per 5 years of follow-up). Adjustment for OCM variables did not affect previously reported associations between arsenic metabolism and diabetes-related outcomes; however, the association between the MTR variant and all diabetes-related outcomes were attenuated or reversed direction after adjustment for arsenic metabolism. Our findings suggest MMA% may be a partial mediator in the association between OCM and diabetes-related outcomes. Formal mediation analyses are needed to confirm this finding. Additional research is needed to determine whether excess B vitamin intake is associated with increased risk for diabetes-related outcomes.

## **004.01.17. A Suspected Mesothelioma Cluster in Colombia: What We Know**

Juan Ramos-Bonilla

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**Abstract:** Introduction: Asbestos are mineral fibers that have been used in a wide range of products. All forms of asbestos cause mesothelioma and cancers of the lung, larynx, and ovaries. The asbestos industry began operations in Colombia in 1942, with an asbestos cement facility located in the municipality of Sibate (current population 38,000). Historically the plant produced asbestos-cement roof tiles and water pipes. The latest figure available indicates that in 2012 the facility used 5,955 tons of asbestos. Inhabitants of Sibate have been complaining that a large number of people are being diagnosed and are dying from asbestos related diseases. Aim: The aim of this study is to investigate the potential existence of a mesothelioma cluster in Sibate. Methods: In 2015/16, 354 door-to-door health and socioeconomic surveys were applied in three large neighborhoods, to identify potential asbestos related cases. Asbestos exposure sources have also been studied, including soil-sampling campaigns conducted at locations that were determined using Geographic Information Systems. Results: Thirty-one (31) self-reported mesothelioma cases were identified with the surveys. For 21 of these cases, a copy of the medical diagnosis has been obtained (14 with immunohistochemistry report), as an initial step to confirm the original diagnosis. Core biopsy paraffins for each case are currently being collected for validation purposes. During the soil survey campaign, an underground layer of friable asbestos (chrysotile content 5-10%) was identified at different depths. This asbestos layer was created during the construction of landfills intended to desiccate areas of a water reservoir located next to the town. Conclusion: With the information collected so far, 3 of the 5 criteria established by the US CDC cluster investigation guidelines have been met. At this stage, the case in Sibate can be labeled as a suspected mesothelioma cluster, pending further confirmation of the mesothelioma diagnosis.

**004.01.18. Describing Roles for a Range of Natural Environments in Adverse Mental Health Outcomes and Neighborhood Social Cohesion across Metro Vancouver, Canada**

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**Abstract:** In a rapidly urbanizing world, identifying evidence-based strategies to design healthy cities is essential. Although urban living offers increased access to critical resources and can help to mitigate climate change, dense environments are often higher in physical and psychological stressors and lower in social cohesion, which is known to support health. One component of urban form that can ameliorate these stressors is nature: greenspace such as parks and street trees and bluespace such as rivers and oceans. In this project, we applied a Natural Space Index (NSI) previously developed for greater Vancouver, Canada to explore the relationship between the presence, access, and form of natural space and: (1) major depressive disorder; (2) negative mental health; and (3) psychological distress. In addition, we examined associations between the NSI and perceived social cohesion (measured via self-reported sense of community belonging [SoC]), as well as potential mediation of the relationship between nature and mental health via increased SoC. Using data from the nationally representative cross-sectional 2012 Canadian Community Health Survey-Mental Health (sample weighted  $n=1,930,048$ ), we found no associations between any NSI measures and mental health in models adjusted for 11 demographic, socioeconomic, household arrangement, health, and urban design confounders. However, two measures of publicly accessible neighborhood (500m) nature were associated with increased odds of higher SoC: percentage of public greenspace [AOR=1.05/95%CI=1.00, 1.10 for very strong vs. very weak SoC] and percentage of public natural space [AOR=1.05/95%CI=1.01,1.10 for very strong vs. very weak; AOR=1.04/95%CI=1.01,1.08 for somewhat strong vs. very weak]. In addition, higher levels of SoC were associated with improvements in all three mental health outcomes. These findings suggest an indirect effect of publicly accessible nature on improved mental health via increased social cohesion.

O04.01D. Health Outcomes and Biomarkers Associated with Household Cooking and Biomass Burning 2

**O04.01.19. Cardiovascular and Respiratory Effects of a Cookstove Intervention in Two Rural Communities in Western Kenya**

Gregory Wellenius

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**Abstract:** Background: Household air pollution (HAP) from incomplete combustion of solid fuels is associated with substantial cardiopulmonary mortality, particularly in developing countries. We examined the impact of a cookstove replacement intervention on indoor fine particulate matter (PM<sub>2.5</sub>), carbon monoxide (CO) concentrations, and markers of cardiovascular and respiratory health. Methods: We enrolled 99 women (mean age: 34.4 years, SD: 7.4) from two Kenyan rural communities in a cookstove intervention study. We measured 24-hour HAP concentrations, resting blood pressure (BP) with an automated sphygmomanometer, and performed spirometry and pulse oximetry before and 1 and 6 months after stove intervention. We used robust mixed effects linear regression models to estimate post-intervention (versus pre-intervention) changes in HAP and health outcomes, adjusting for age, education, and study site. Results: Pre-intervention median (IQR) CO and PM<sub>2.5</sub> levels were 19.0 (9.0-40.8) ppm and 64.0 (36.0-127.0) µg/m<sup>3</sup>, respectively. All participants reported using wood as their primary cooking fuel, with 93% having no access to a gas cook stove and 88% having no access to electricity. Cookstove intervention was associated with 12.5 (95% CI: 8.8, 16.3) ppm lower mean CO, 23.6 (4.6, 42.7) µg/m<sup>3</sup> lower mean PM<sub>2.5</sub>, 3.9 (1.3, 6.5) mmHg lower systolic BP mmHg, 1.2% (0.8%, 1.6%) higher perfusion index, and 5.5 (3.1, 7.9) bpm lower resting pulse rate at 6 months post-intervention versus baseline. Non-significant improvements in diastolic BP, exhaled CO, carboxyhemoglobin, and peak expiratory flow were also observed. Site-specific estimates varied slightly but trended in the same direction. Conclusion: Among healthy women in two rural Kenyan communities exposed to high levels of HAP, cookstove intervention was associated with lower levels of HAP and improvements in some markers of cardiovascular health after 6 months.

#### **O04.01.20. Indoor Air Pollution and Reduced Lung Function in Biomass Exposed Women: A Cross Sectional Study in Pune District, India**

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Abstract: Indoor air pollution especially from the use of biomass fuels, remains a potentially large global health threat. The inefficient use of such fuels in poorly ventilated conditions results in high levels of indoor air pollution, most seriously affecting women and young children. The main aim of this study was to measure and compare the lung function of the women exposed in the biomass fuels and LPG fuels and relate it to the indoor emission measured using a structured questionnaire, spirometer and filter based low volume samplers respectively. This cross-sectional comparative study was conducted among the women (aged > 18 years) living in rural villages of Pune district who were not diagnosed of chronic pulmonary diseases or any other respiratory diseases and using biomass fuels or LPG for cooking for a minimum period of 5 years or more. Data collection was done from April to June 2017 in dry season. Spirometer was performed using the portable spirometer to determine the lung function over Forced expiratory volume. The primary outcome variable was forced expiratory volume in 1 second (FEV1). Secondary outcome was chronic obstruction pulmonary disease (post bronchodilator FEV1/ Forced Vital Capacity (FVC) < 70%) as defined by the Global Initiative for Obstructive Lung Disease. Potential confounders such as age, height, weight, smoking history, occupation, educational status were considered. Preliminary results showed that the lung function of the women using Biomass fuels had comparatively reduced lung function than the LPG users . The mean PM 2.5 mass concentration in the biomass user's kitchen was higher than in the LPG user's kitchen. Black carbon amount was found higher in the biomass users than LPG users . Therefore, there is an urgent need to adopt various strategies to improve indoor air quality.

#### **O04.01.21. Personal Exposure to Household Air Pollution and Lung Function in Rural Bangladesh: A Population Based Cross-Sectional Study**

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Abstract: Household Air Pollution (HAP) from biomass fuel use is associated with adverse respiratory outcomes. Assessment of individual level exposure to HAP and respiratory outcomes are scarce. We are assessing association between personal exposures to HAP with lung function parameters in a population-based Bangladesh GEOHealth study. We are measuring particulate matter <2.5 micrometers (PM<sub>2.5</sub>), carbon monoxide (CO) and black carbon (BC) using personal monitors (RTI MicroPEM and Lasker CO data logger) in non-smoking women and men (n=600) aged between 25 and 65 years using biomass fuel for cooking in rural Bangladesh. The PM<sub>2.5</sub> mass is being determined by weighing the Teflon filter that accumulates PM<sub>2.5</sub> for 24hr (48hr for a subset) in the MicroPEM. BC concentration is being determined by reflectance measurement using EEL-type Smoke Stain Reflectometer. Post bronchodilator spirometry is being conducted to measure force expiratory volume in 1st second (FEV<sub>1</sub>), force vital capacity (FVC) and their ratio (FEV<sub>1</sub>/FVC) using a spirometer (nidd EasyOne™). In this preliminary analysis of 100 women aged 40±8 years (Mean±SD), median duration of cooking with biomass was 18 years with an average daily cooking time for 2.1hr. The average 48hr personal exposure to PM<sub>2.5</sub>, CO and BC was 124±108µgm<sup>-3</sup>, 1.2±0.9ppm and 4.7±2.1µgm<sup>-3</sup> respectively. About 86% of the women were exposed to PM<sub>2.5</sub>≥50µgm<sup>-3</sup> and median exposure to PM<sub>2.5</sub> during cooking was 233µgm<sup>-3</sup>. Mean post bronchodilator FVC, FEV<sub>1</sub> and FEV<sub>1</sub>/FVC were 2.6±0.5L, 2.1±0.4L and 80±8% respectively and 9% had irreversible obstruction (FEV<sub>1</sub>/FVC<0.70). We observed an inverse relationship between exposure to PM<sub>2.5</sub>>100µgm<sup>-3</sup> and lung function parameters in adjusted models but relationships were not statistically significant. Similar relationship between exposure to BC>3µgm<sup>-3</sup> with lung function parameters were also observed. Our preliminary findings indicate that lung function was affected by HAP. We will perform further analysis with data on total sample.

#### **O04.01.22. Assessing Changes in Exposure and Women's Health among Households Using Different Cooking Fuels in Chitwan, Nepal**

Parth Sarathi Mahapatra

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Abstract: Household air pollution (HAP) resulting from solid fuel use for cooking/heating is a major problem of South Asia. In Nepal, despite HAP being a key issue there is a dearth of studies that presents a comprehensive overview of environmental factors, emissions, exposure, and health burden present. We use a multi-parameter approach to identify the changes in emission, exposure and health condition of women involved with using different types of cooking fuel. The associated environmental and socio-economic factors influencing their exposure and health were studied using a structured questionnaire. The study was conducted in 2017 summer in four villages (Simreni, Gathauli, Maggar, Jancauli) of Chitwan, Nepal. 80 women between 20-30 years of age, using four different types of cooking fuel (biomass, biogas, liquefied petroleum gas (LPG) and a mix of biogas/LPG and biomass) participated in the study. Personal and indoor exposure measurements were undertaken using established low cost sensors for particulate matter (PM), black carbon (BC) and carbon monoxide (CO). Short term physiological changes were measured using standard equipment for blood pressure, lung function, and saturated oxygen content. Exhale breathe CO was also measured as a biomarker of HAP exposure. Initial analysis indicates higher exposure to CO (ppm) during cooking with biomass ( $10.4 \pm 9.1$ ) in comparison to mixed ( $8.2 \pm 7.5$ ), biogas ( $2.7 \pm 0.3$ ) and LPG ( $1.7 \pm 0.7$ ). The exhale breathe CO was observed to be the highest in biomass users ( $6.9 \pm 3.8$ ) followed by mixed ( $6.4 \pm 2.9$ ) and almost similar in LPG ( $4.9 \pm 1.5$ ) and biogas ( $4 \pm 1.7$ ) users. FEV1/FVC ratio measured immediately after cooking did not show a strong variation with different cooking fuel users ( $85.2 \pm 7.8$ ,  $85.1 \pm 2.4$  and  $85.3 \pm 4.4$  for biomass, biogas and LPG users respectively). Preliminary results suggest changing the cooking fuel from biomass to either biogas/LPG would improve health conditions of women.

### **O04.01.23. Fine Particulate Matter Exposure from Wood-Burning Cookstoves in Relation to Augmentation Index and Blood Pressure among Honduran Women**

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**Abstract:** Limited, but growing epidemiologic evidence exists for associations between household air pollution (HAP) from biomass cookstoves and risk factors for cardiovascular diseases (CVDs). We evaluated the cross-sectional association of fine particulate matter (PM<sub>2.5</sub>) exposure with augmentation index, a measure of arterial stiffness, and blood pressure among women using wood-burning cookstoves in rural Honduras. Data were collected at two baseline visits (dry and rainy season) during a randomized controlled cookstove trial among 224 female primary cooks, aged 25-55 years. Personal and kitchen 24-hour PM<sub>2.5</sub> were measured gravimetrically using AirChek XR5000 pumps and Triplex Cyclones; central augmentation index and brachial blood pressure were collected via the Sphygmocor XCEL. We evaluated the associations between PM<sub>2.5</sub> and augmentation index (both log-transformed) and blood pressure in separate mixed effects regression models adjusted for age, years of school completed, waist-hip ratio, dietary diversity score, physical activity (log-transformed), and mean kitchen temperature. Median 24-hour PM<sub>2.5</sub> concentrations were 83 (25th percentile: 51; 75th percentile: 141) µg/m<sup>3</sup> and 197 (25th percentile: 81; 75th percentile: 473) µg/m<sup>3</sup> for personal and kitchen measurements, respectively. The adjusted difference in augmentation index per 10% increase in kitchen and personal PM<sub>2.5</sub> was -0.01% (95% CI, -0.13, 0.10) and -0.05% (95% CI, -0.21, 0.10), respectively. Results for systolic and diastolic blood pressure were also consistent with a null association. We did not observe any seasonal effects on the results. These results are not consistent with existing literature supporting an association between HAP and blood pressure. Given the elevated PM<sub>2.5</sub> concentrations at baseline in this study, the results may be consistent with the hypothesized supralinear exposure-response curve between HAP and CVD that suggests weaker or no association at higher concentrations.

**O04.01.24. Title: Exposure to Household Air Pollutants (HAP) and Microvascular Function (Reactive Hyperemia Index, RHI) in Rural Bangladesh: A Cross Sectional Study**

Mohammad Shahriar

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**Abstract:** More than one-third of world's population uses biomass fuel for cooking. Use of biomass fuel has been linked to an array of adverse health hazards including cardiovascular mortality and morbidity. As part of Bangladesh GEO Health project, we are assessing whether HAP is associated with preclinical markers of cardiovascular disease (CVD) including dysfunction in microvascular circulation (by RHI). We are measuring exposure to HAP [(PM<sub>2.5</sub>, Carbon monoxide(CO) and Black carbon(BC)] for 24 hours (48 hours for a subset of 200) among 600 healthy nonsmoker adults who use biomass fuel for cooking. Exposure to PM<sub>2.5</sub> and BC has been measured using a personal monitor, RTI MicroPEM<sup>TM</sup> that use light scattering methods and also gravimetrically with an internal filter that has been both pre and post-weighed to have the deposited pollutants concentration. Laskar CO logger is being used to measure CO. Microvascular function has been measured by forearm blood flow dilatation response to brachial artery occlusion using Reactive Hyperemia-peripheral arterial tonometry (RH-PAT), a finger plethysmographic device (EndoPAT 2000, ITAMAR) which yield RHI index. A low RHI score (<1.67) indicates impaired endothelial function. Since the recruitment is underway, we have analyzed on the first 100 participants recruited to date. Average 48 hour personal exposure to PM<sub>2.5</sub>, BC, and CO, is 124 $\mu$ g/m<sup>3</sup>(SE 11.2), 4.8  $\mu$ g/m<sup>3</sup> (SE 0.2) and 1.2 ppm (SE 0.8) respectively. Mean RHI is 1.65 (SD 0.44) in our current data which is slightly below the cutoff (1.67). RHI is inversely associated with BC (OR .94, 95% CI: .7684078, 1.154878) but not significant at 5% level. No association is found with PM and CO in a preliminary analysis. As per the preliminary analysis, BC has a negative effect on CVD, Mean PM<sub>2.5</sub> is relatively much higher than the normal allowable limit. We will present complete analysis at the meeting after completion of recruitment by June 2018.

## O04.01E. Investigating Exposures to PAHs

### **O04.01.25. Temporal Trend of Exposures to Polycyclic Aromatic Hydrocarbons and Bisphenol A during 2012-2016: A Comparison between China and the United States**

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**Abstract:** At national scales, changes in human exposures to environmental chemicals are largely driven by government's regulatory actions. Due to the inter-country variations in social, cultural, and economic conditions, the temporal trends of human exposures to chemicals are likely to be different among countries. To test this hypothesis, urine samples (n=350) were collected from four panels of summer exchange students (n=45) between University of California, Los Angeles (UCLA, in Los Angeles, United States) and Peking University (in Beijing, China) in 2012, 2014, 2015, and 2016. The urinary metabolites of two groups of environmental pollutants, namely polycyclic aromatic hydrocarbons (PAHs) and bisphenol A (BPA) were measured. In each year, exposures to PAHs and BPA were both significantly higher in Beijing than in Los Angeles ( $p < 0.05$ ). From 2012 to 2016, PAHs exposures didn't change in Los Angeles, but continuously decreased in Beijing ( $p < 0.01$ ) which was probably due to the drastic reduction in PAHs emissions from residential, commercial, and industrial sources in China. BPA exposures, by contrast, continuously decreased in Los Angeles ( $p < 0.001$ ), but didn't change in Beijing. This is likely due to extensive efforts from government and manufacturers to phase out BPA in the United States and calls for actions to regulate BPA in China. Overall, the observed temporal trends of PAHs and BPA exposures reflect the difference in pollution controlling measures between the two countries.

#### **O04.01.26. Identifying Prenatal PAH Exposure and DNA Methylation Changes in Cord Blood Using a Novel Analytic Approach**

Ya Wang

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Abstract: PAH are ubiquitous in the urban environment, generated by combustion processes. Ambient PAH penetrate into the indoor environment. The CCCEH cohort study in NYC, a participant in the NIH ECHO consortium, has documented adverse neurodevelopmental, metabolic, and respiratory outcomes associated with prenatal PAH exposure. We analyzed DNA methylation in N=432 cord blood samples (total white blood cells), with 168 using the 450K and 264 using the EPIC array, with 485,577 and 866,895 CpG sites, respectively. We conducted standard quality control steps where we removed CpG sites on sex chromosomes, those overlapping with SNPs or on multiple locations, and kept overlapping CpG sites covered by both arrays with gene annotations, leaving 292,310 CpG sites covering 18,830 genes. We developed a weighted epigenetic distance-based method characterizing (dis)similarity in methylation measures at multiple CpGs in a gene / genetic region between pairwise samples, with weights to up-weight signal CpGs and down-weight noise CpGs. Using similarity-based approaches, weak signals that might be filtered out in a CpG-site-level analysis could be accumulated and boost the overall power. In constructing epigenetic distances, we considered both differential methylation and variation signals (method manuscript to be submitted). We applied this method to identify genes that show methylation alterations between samples with high and low prenatal PAH exposures (dichotomized at the median 2.26 ng/m<sup>3</sup>). After accounting for cell distribution and multiple comparisons, we identified 19 significant genes (FDR < 0.05). The 19 genes include RGS18, SNORD114-5, SNORD114-31, -22, and -28, PMCH, TMEM159, TMED6, OR1D2, MOBKL2B, HBB, WDR3, C9orf119, C4orf35, SNORD114-26, TXLNB, KRTAP1-3, SLC2A8 and C20orf165. This approach shows promise for identifying potential risks and mechanistic pathways associated with low-level exposures to PAH and other pollutants, which are common among pregnant women and their babies.

#### **004.01.27. Household-Level Population Estimates and Building Setbacks near Underground Natural Gas Storage Wells in PA, OH, NY, WV, MI, and CA**

Drew Michanowicz

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Abstract: Health impacts have been reported in people living near oil and gas operations (e.g., asthma exacerbation). Towards assessing these risks, studies quantifying proximate populations generally assume an even spatial distribution of population within an administrative unit (e.g., census block). These proportion population allocation (PPA) methods can be improved by excluding non-residential land use areas (i.e. dasymetric mapping), but are still too imprecise to obtain reliable estimates of population densities at small spatial scales (e.g., 50m<sup>2</sup>). Here we present ABODE (Allocation By Occupied Domicile Estimation), a novel household-level population estimation method that combines geospatial addresses, building footprints, and U.S. Census data. We assess ABODE and PPA methods by comparing population estimates within 200m of active underground natural gas storage (UGS) wells (n = 8,963) in six U.S. states. Overall, ABODE predicts slightly higher population estimates compared to PPA (48,126 vs. 43,052); however estimation bias varied by state and by individual well. ABODE captured higher populations within 200m of UGS wells in OH, WV, and PA with increases of 6, 54, and 66% compared to the PPA method, respectively. Conversely, the ABODE method captures fewer populations in NY, MI, and CA, with decreases of 4, 7, and 26%, respectively. By explicitly identifying households near active UGS wells in the six states, we also quantify well-to-building relationships and compare to state surface setback regulations where they exist. An estimated 9.4% (840) of UGS wells across the six states have at least one building within a regulated setback distance. This results in 2,769 households, or an estimated 4,816 people, living within these states' respective setbacks (e.g., 100 - 625ft.). The spatially-resolved nature of the ABODE method provides a clear advancement from previous proximity-based methods towards understanding present and future land-use conflicts.

## **O04.01.28. Validation of Silicone Wristbands as Passive Samplers for the Assessment of Exposure to Flame Retardants and Polycyclic Aromatic Hydrocarbons**

Marta Venier

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Abstract: Personal passive samplers are seeing increasing use as they do not require energy during deployment, they are cost-effective and less-invasive, and can represent exposures integrated over a longer time-period than active samplers. Silicone wristbands have recently been used for characterizing personal exposure to a variety of chemicals but it remains unclear what route of exposure the wristband represents. We hypothesized that wristbands integrate inhalation and dermal exposure. This study examined the relationship between exposures measured using three methods: wristband, traditional active sampler and skin wipes. Exposure of each adult participant (n=10) was measured for 72 consecutive hours. During this period each participant wore one silicone wristband, one silicone brooch/badge (PDMS) and an active personal air sampler containing a glass fiber filter followed by a PUF/XAD/PUF sandwich for 72 consecutive hours. Participants also collected hand wipes samples each time before washing their hands during the 72 hour period. Samples were analysed for 9 polycyclic aromatic hydrocarbons (PAHs) and 13 flame retardants (FRs), including novel brominated flame retardants (NFRs), polybrominated diphenyl ethers (PBDEs), and organophosphate esters (OPEs) using gas chromatography mass spectrometry. BDE-47, 99, and 209 were the most abundant among PBDEs, EHTBB, BEHTBP, and DBDPE among NFRs, TCEP, TCIPP, and TPHP among OPEs, and phenanthrene among PAHs. Preliminary results indicate that PBDEs, NFRs, OPEs, and PAHs in wristbands were in the range 0.1 to 6 ng/g band, 0.1 to 10 ng/g band, 0.1 to 200 ng/g band, and 0.1 to 20 ng/g band, respectively. Levels measured in wristbands were positively correlated with levels in hand wipes and OVS samples, confirming our hypothesis. We conclude that silicone wristbands are suitable for quantitative assessment of human exposure to a large range of chemicals simultaneously, and this exposure represents both inhalation and dermal contact.

## **O04.01.29. Critical Review: Human Health Literature Related to Unconventional Oil and Natural Gas Development**

Anna Rosofsky

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**Abstract:** Background Development of oil and natural gas from unconventional resources (UOGD) has expanded rapidly in the last decade, and increased public and academic interest has led to a growing body of literature about its potential health effects. This review summarizes the epidemiological evidence and what the body of literature does and does not tell us about the relationship between UOGD and health. **Methods** The Health Effects Institute's Energy Research Committee (the Committee), consisting of multidisciplinary experts from across the U.S., along with HEI staff systematically reviewed the peer-reviewed and gray epidemiologic literature published between January 2000 and March 2018 by searching several electronic databases and consulting with expert stakeholders. The Committee elected to review analytical epidemiological studies worldwide with a primary focus on UOGD exposure and human health outcomes to assess whether the health of people living in locations affected by UOGD are adversely affected by the operations. Each study was assessed in duplicate for quality and risk of bias using an approach based on guidance from the National Toxicology Program Office of Health Assessment and Translation. **Results** The epidemiologic studies report associations between UOGD and various outcomes, including perinatal effects, asthma, cancer, hospitalizations and self-report health symptoms. Study authors discuss limitations of their studies, including reliance on imprecise proxies for UOG Exposure, with many noting that causality cannot be assessed without better exposure measures. This presentation will provide the Committee's findings about the strengths and weaknesses of this body of literature. **Conclusions** This systematic, impartial literature review will be useful to regulators, scientists, and others interested in understanding what is known about potential health effects of UOGD, what knowledge gaps remain, and how important knowledge gaps could be filled with future research.

#### **O04.01.30. Bioaccessibility of Polycyclic Aromatic Hydrocarbons in Airborne Particulate Matter Assessed by Simulated Lung Fluids: A Panel Study of Different Cities in Northern China**

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**Abstract:** Background: As even slight adjustments in the estimation of airborne PM-bound PAHs bioaccessibility can significantly alter risk assessment results, convenient and reliable tools are needed to determine PAHs bioaccessibility in respiratory system. Objectives: In this study, we measured 12 priority pollutant PAHs (PAH12) and estimated the lifetime excess inhalation cancer risk using their bioaccessible concentrations after simulated lung fluids extraction. Methods: Airborne PM with  $\leq 2.5 \mu\text{m}$  aerodynamic diameter (PM<sub>2.5</sub>) samples were collected from four typical cities in northeast China during the heating periods. Artificial lysosomal fluid (ALF) and Gamble's solution were used to determine PM<sub>2.5</sub>-bound bioaccessible PAH12 to calculate associated lifetime excess inhalation cancer risk by employing point-estimate approach based on relative potency factors. Results: The numbers of lifetime excess cancer cases owing to PAH12 exposure (total concentration) were 43-440 (provincial central city), 42-261 (energy mining city), 17-109 (forest city), and 20-70 (agricultural city) per million people, which corresponded to 88.81% and 94.15%, 89.12% and 96.48%, 87.49% and 89.40%, and 83.76% and 90.60% decrease in the estimated inhalation cancer risk considering bioaccessibility following 24-h Gamble's solution and ALF extraction, respectively. Benzo[k]floranthene (BkF), dibenz[a,h]anthracene (DahA) and benzo[a]pyrene (BaP) were the most bioaccessible PAH12 in the PM<sub>2.5</sub> samples after Gamble's solution extraction and were commonly found in all the cities studied. Conclusions: PAH12 concentrations widely varied across different cities affected by various PM<sub>2.5</sub> emission sources. Based on the point-estimate approach, short-term predictions of pulmonary toxicity caused by airborne PM might be underestimated if the bioaccessibility of PM<sub>2.5</sub>-bound PAH12 are not fully evaluated. Dibenz[a,h]anthracene (DahA) is a significant contributor to the estimated overall inhalation cancer risk.

## O04.01F. New Methods and Novel Matrices in Chemical Monitoring

### O04.01.31. Method Development and Validation of Dried Blood Spots as a Tool for Mercury Exposure Assessment

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Abstract: Dried blood spots (DBS) provide a minimally invasive collection method with potential to be used as a field-based research tool for exposure to environmental contaminants such as mercury (Hg). Even though previous studies provided novel techniques to measure Total Mercury (THg) and Methylmercury (MeHg) in residual DBS from newborn screening programs, a range of limitations remains including challenges with detection limit, lack of mercury speciation, and validation with paired DBS-Blood samples collected under laboratory conditions. This study follows our previous work on the matter and specifically evaluates the suitability of DBS to assess methylmercury (MeHg) and THg exposure in human and fish blood samples. It focuses on paired DBS-blood samples from venous and capillary sources of 49 human volunteers, and 10 fish (Arctic Char) samples. Paired DBS-blood, reference material and venous blood from one volunteer, was used to develop the analytical method. We used a GC-CVAFS to analyze MeHg and a Dual-Stage Gold Preconcentration for THg. Method development results based on EPA1630 guidelines, wet spikes and the use of blood reference materials showed that the measurement of MeHg in whole blood and DBS was both accurate (95-107%) and precise (2-11%). Initial results showed a high correlation for DBS-blood ( $r^2=0.83$ ) for MeHg (average  $0.96 \pm 0.73 \mu\text{g/L}$ ) for human samples, as well as for DBS-blood fish samples MeHg ( $r^2=0.94$ ), (average  $919.46 \pm 492.97 \mu\text{g/L}$ ). When coupled with other recent work in this area, there is growing confidence in the use of DBS samples to measure MeHg exposure.

## **O04.01.32. Calibration and Validation of X-Ray Fluorescence Measurements for Non-Destructive Metal Exposure Assessment of Toenail Clippings from Nigeria**

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Abstract: Environmental exposure to metals has been shown to adversely affect neurologic health, cardiovascular health, and almost every system in the body. Exposure to metals has been tracked primarily using blood, which can have drawbacks as a biomarker when considering biologic half-life, collection, and storage. Toenails, which capture a longer exposure period, can be collected non-invasively, and stored at room temperature, could be much easier and more cost effective for large-scale population studies. Inductively coupled plasma mass spectrometry (ICP-MS) is typically used for analysis of toenail metal concentrations, but x-ray fluorescence (XRF) has many advantages in versatility and cost effectiveness over ICP-MS. This study compared toenail metal measurements made with XRF against ICP-MS among toenail samples collected from 20 adults in Nigeria. To do this we developed a novel calibration method that allows for correction of XRF measurements for toenail weight and thickness to accurately use XRF measurements of toenail clippings to quantify metal concentrations. We demonstrate the validity of this method in comparison to typical ICP-MS methods by comparing toenails collected from a community living in Nigeria. We found that toenail weight (correlation  $R=0.84$  between spectral estimates of weight and actual weight) and thickness (correlation  $R=0.99$  between spectral estimates of thickness and actual thickness) can be corrected for using a new calibration technique with XRF. XRF measurements of toenail Mn are comparable to ICP-MS ( $R=0.91$ ). XRF can be used effectively to quantify metals to part per million with typical XRF equipment or down to part per billion with more powerful equipment. Finally, we show that individuals living in this polluted community have much higher levels of metal exposures than typical in occupationally exposed groups.

### **O04.01.33. Moss Biomonitoring as an Alternative to Assess Exposure to Atmospheric Metals in Environmental Epidemiology: The Example of the Bramm Network and the Constances Cohort**

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**Abstract:** Background/Aim Very limited data on atmospheric metals are available nationwide with conventional devices for epidemiological research. The moss biomonitoring approach - based on the ability of mosses to proxy levels of atmospheric metals - offers an alternative. Our objective is to assess the feasibility to assign atmospheric metals exposure estimates at home addresses, using moss biomonitoring, in a large general population-based epidemiological cohort. Methods Framed by BRAMM, the French network of moss biomonitoring, mosses were surveyed for their content in 13 metals including Cd, Hg and Pb in 1996, 2000, 2006 and 2011 in 449-559 rural forest sites. After sample preparation and chemical analyses, data were interpolated by kriging to produce 2x2 km maps, from which we extracted levels of atmospheric metals at the residential address of the expected 40,000 Constances's participants living in low and moderate population density areas. Results Based on our experience in another French cohort, we expect to obtain a high spatial and temporal variability of exposure for all metals (e.g. 38 to 139 ng.g-1 for Hg, or 1.8 to 49.8 mg.g-1 for Pb). Exposures to most atmospheric metals followed gradients of population density and showed higher concentrations in industrial regions, such as the Parisian region, the North or the Rhone valley even if such data do not seem suitable for urban areas due to the characteristics of moss collection. Conclusion Moss biomonitoring is a convincing tool to assess exposure to atmospheric metals, at least in non-urban areas, and can be easily associated to epidemiological data. Two campaigns in Paris and Lyon - the main French cities - are planned to collect and use moss biomonitoring in urban areas to complete our dataset.

#### **O04.01.34. Comparison and Agreement between Venous and Capillary Blood for the Analysis of Trace Elements**

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Abstract: The use of capillary blood has many advantages over traditional venipuncture, and it has been proposed as an alternative to the use of venous blood in many fields. Since capillary blood is not identical to venous blood, there is a need to validate that both types of blood yield quality results in different applications. The aim of this study was to evaluate the agreement between capillary and venous blood for trace elements assessment and several hematological parameters. As, Cd, Ni, and Pb were determined in capillary and venous samples by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) from 49 students (ages 18-36 years). Descriptive statistics and quality control parameters were calculated to review the data. The White Blood Cells (WBC) and Red Blood Cells (RBC) counts, the Hematocrit (Ht) %, and the Hemoglobin (Hb) levels were also analyzed. The precision of the method was between 6.1-15.2% for As, Cd, and Pb, while the accuracy was between 97.8-126.2% for the same elements. Ni concentrations remained below the Limits of Detection in 38% of the venous blood samples, affecting the relationship determination between the two types of blood. The results demonstrated high significant relationships for the elements of As ( $r^2= 0.866$ ), Cd ( $r^2= 0.667$ ), and Pb ( $r^2= 0.966$ ) between venous and capillary blood. The hematological parameters were highly similar. RBC and WBC counts in capillary blood were 4.67  $10^{12}/L$  and 6.70  $10^9/L$ , and 4.76  $10^{12}/L$  and 6.55  $10^9/L$  for venous blood, respectively. The Ht and Hb levels for capillary blood were 40.3% and 13.76 g/dL, and 41.2% and 13.87 g/dL for venous blood. The agreement between venous and capillary blood was determined by constructing Bland-Altman plots. The mean differences were 0.073, -0.088, and -0.38 for As, Cd, and Pb. These results demonstrate the capacity of capillary blood to be used as an alternative biomarker and its potential to be used in cost-effective methods for exposure assessment.

**O04.01.35. Nutrition Transition and Total Nail Selenium in the Peruvian Amazon in the IMAS Study (Investigacion De Migracion, Ambiente, Y Salud)**

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Abstract: Road development has been a major driver of the transition from traditional to calorie-dense processed 'Western' diets in lower and middle income countries. The paving of the Inter-oceanic Highway (IOH) brought rapid development to the Madre de Dios (MDD) region in the Peruvian Amazon. As traditional foods such as Brazil nuts and fish are high in selenium, we hypothesized that nail selenium may be an appropriate biomarker to measure the nutrition transition. To test this hypothesis, in 2014 we collected household surveys from 310 households in 46 communities along the IOH and nails from 418 adults. Principal component analysis of consumption frequency of 26 food items identified a Western diet factor, and we calculated household Western diet weighted sum factor scores. Diet score means were mapped into a 10 km buffer around the IOH. Generalized estimating equations (GEE) assessed the effect of this score on individual nail selenium. GEE's also assessed the influence of each food on nail selenium in urban and rural localities. Sharp differences in nail selenium were observed between urban and rural communities in an area dominated by subsistence agriculture, and higher rates of dietary transition in areas dominated by small scale artisanal gold mining and population influxes. Urban/rural status modified the effect of Western diet on nail selenium: we estimate the total nail selenium of an urban, 47 year-old (mean-aged) non-smoker would decrease 23 ng/g per unit increase in Western diet score, while rural counterparts would experience a 6 ng/g increase in selenium. Chicken, a non-traditional food, was positively associated with selenium in the rural stratum only. It is possible that chickens consumed in rural areas are raised in the household and exposed to selenium-rich local soils and food scraps. We conclude that total nail selenium is not an appropriate biomarker for stage of dietary transition in the primarily rural settlements in MDD.

#### **004.01.36. Silicone Cat Tags Detect Feline Flame Retardant Exposures**

Carolyn Poutasse

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Abstract: Since the first clinical diagnosis in 1979, the prevalence of feline hyperthyroidism in the United States has increased from 1 in 300 to 1 in 10 domesticated geriatric cats. Similar prevalence statistics are reported worldwide. Although histologically similar to human toxic nodular goiter, the underlying causes of feline hyperthyroidism remain unknown. There is some evidence that exposure to endocrine-disrupting compounds with thyroid targets may contribute to the development of feline hyperthyroidism and toxic nodular goiter. This includes exposures to brominated flame retardants (FRs), such as polybrominated diphenyl ethers (PBDEs). FR exposure routes (e.g. inhalation) are the same between cats and humans, such that cats can be used as sentinels for human exposures. In this study, silicone passive sampling devices, or cat tags, quantitatively assessed the bioavailable fraction of household FRs. Participating cats wore a cat tag for 7 days, and targeted analysis by gas chromatography mass spectrometry included 41 legacy and current FRs. Preliminary data indicated that 3 non-hyperthyroid cat tags detected a total of 11 PBDEs and organophosphate ethers. Tris(2-chloroisopropyl)phosphate (TCPP), triphenyl phosphate, and BDE-47 were detected above the limit of quantitation in all 3 cat tags. TCPP was detected at the highest concentration in each tag, ranging from 1.35 to 32.3 ng/g cat tag. This study provides proof-of-concept data for the use of silicone cat tags with companion animals and demonstrates that cat tags can compare FR concentrations in homes of hyperthyroid and non-hyperthyroid cats.

## O04.01G. Noise Effects 2

### **O04.01.37. Long-Term Residential Exposure to Environmental Noise and Cardiovascular Disease Onset: A Population-Based Cohort Study**

Larisa Yankoty

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**Abstract:** Introduction: Cardiovascular effects of environmental noise are a growing concern. However, the evidence remains largely limited to the association between road traffic noise and hypertension and ischemic diseases especially myocardial infarction (MI). Objective: To examine associations between long-term residential exposure to total environmental noise and the onset of cardiovascular MI and strokes in adults of the Island of Montreal. Methods: An open cohort of 1,087,806 adults aged  $\geq 45$  years, free of MI and strokes before entering the cohort was created for the years 2000 to 2014 with the Quebec Integrated Chronic Disease Surveillance System, a systematic surveillance system from the second most populous province in Canada starting in 1996. The exposure to total environmental noise (LAeq24h) at cohort entry was estimated with a Land Use Regression (LUR) model. Onsets of MI and strokes were based on one hospital admission. Cox models were used to estimate associations. Results: We found positive associations between LAeq24h estimated and the occurrence of MI and strokes; hazard ratios adjusted for age, sex, year of entry, social and material deprivation indexes and traffic-related air pollutant (nitrogen dioxide) were respectively 1.10 (95% CI: 1.07-1.13) and 1.06 (95% CI: 1.03-1.09) per 10 dBA. Conclusion: These results suggest that total environmental noise is associated with the onset of MI and strokes. Future work should clarify if associations vary by noise sources, and if pre-existing diseases (e.g. hypertension) mediate such effects.

## **O04.01.38. Time-Varying Aircraft Noise Exposure and Incident Hypertension in the Nurses' Health Study**

Chloe Kim

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**Abstract:** Background: Aircraft noise is of primary concern for communities living near airports. There is accumulating evidence of a relationship between aircraft noise and hypertension. However, most studies are cross-sectional or case-control, with limited numbers of prospective cohort studies and none in the U.S. This study aims to evaluate the association between long-term aircraft noise exposure and hypertension among participants in a large U.S. prospective cohort, the Nurses' Health Study (NHS). Methods: Day-night average sound levels (DNL) 45-75 dB were modeled for 90 airports in the U.S. for 1995-2015 in 5-year intervals using the Aviation Environmental Design Tool and were linked to geocoded addresses of participants in NHS. We performed time-varying Cox proportional hazards models for hypertension incidence to estimate hazard ratios (HRs) for each 1 dB increase in current DNL, cumulative average DNL, and indicators for current DNL >45 dB (lowest dB considered "exposed") and >55 dB, while adjusting for individual risk factors for hypertension, area-level socioeconomic status, and air pollution. Results: Among the 63,600 NHS participants free of hypertension in 1994, 28,286 new hypertension cases were observed by 2008. In each year, ~10% of the cohort were exposed to DNL levels >45 dB. In multivariable models, current and cumulative average DNL were not associated with hypertension incidence, but current exposure to >45 dB (HR=1.04; 95% CI: 0.99, 1.09) or >55 dB (HR=1.03; 95% CI: 0.89, 1.18) were associated with a suggestive increased risk. Conclusions: To our knowledge, this is the first study to evaluate the association between aircraft noise exposure and the risk of hypertension in a nationwide large prospective cohort study in the U.S. We will be investigating the noise-hypertension relationship in two additional cohorts, NHS II and the Health Professionals Follow-up Study, specifically examining the effect of nighttime aircraft noise exposure.

## **O04.01.39. Long-Term Exposure to Noise and the Development of Diabetes and Hypertension in Toronto, Canada: A Cohort Study**

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**Abstract:** Background: Exposure to noise has been linked to cardiovascular disease risk factors, such as elevated blood pressure and glucose dysregulation. However, epidemiologic evidence linking road traffic noise and cardiovascular disease and its risk factors remains scarce in North America. We assessed associations between road traffic noise and the incidence of diabetes and hypertension in Toronto, Canada, which is the fourth largest city in North America. Methods: We conducted a population-based cohort study of ~1 million individuals, who were aged 35-100 years and long-term residents of Toronto. Noise levels were derived using SoundPLAN Acoustics software as equivalent A-weighted sound pressure level from traffic for nighttime (LAeqNight) and 24-hour day (LAeq24h). Three-year average levels of noise were assigned to subjects' annual residential postal codes. To estimate the association between noise and outcomes, we used random-effect Cox proportional hazards models adjusting for personal and area-level characteristics. We conducted sensitivity analyses, including further adjusting for comorbidities and air pollution (ultrafine particles and nitrogen dioxide). We also fitted three-level categorical variables of noise by 5 dBA increments ( $\leq 45$  dBA and  $\leq 55$  dBA as the reference levels for LAeqNight and LAeq24h, respectively). Results: From 2001 to 2015, each interquartile range increase in LAeqNight (10.0 dBA) was associated with the incidence of diabetes (HR 1.08; 95% CI: 1.07-1.09) and hypertension (HR 1.02; 95% CI: 1.01-1.03). We found similar results with LAeq24h. These results were robust to all sensitivity analyses conducted. For diabetes, when considering noise exposure as a categorical variable, exposure to the highest levels of LAeqNight and LAeq24h was associated with HRs of 1.15 and 1.12, respectively, compared to the lowest levels. Conclusions: Exposure to road traffic noise was associated with increased incidence of diabetes and hypertension in Toronto.

## **004.01.40. Long-Term Transportation Noise Exposure and Incidence of Ischemic Heart Disease and Stroke**

Andrei Pyko

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**Abstract:** Background Exposure to transportation noise is widespread and has been suggested as a risk factor for cardiovascular disease. However, the evidence from longitudinal studies on ischemic heart disease (IHD) and stroke is limited. This cohort study aimed to estimate the association between exposure to noise from road traffic, railways or aircraft and incidence of IHD and stroke. **Methods** We assessed individual long-term exposure to road traffic, railway and aircraft noise based on residential histories in a cohort of 20,012 individuals. The National Patient and Cause-of-Death Registers were used to define IHD and stroke events. Extensive information on potential confounders was available from questionnaires and registers. We computed Hazard Ratios (HR) using Cox proportional hazards regression to assess associations between noise exposure and IHD. **Results** The study base of 245,000 person-years generated 1,363 and 902 incident events of IHD and stroke, respectively. We observed a particularly high risk of IHD in those exposed to all three transportation noise sources at  $\geq 45$  dB Lden, with a HR of 1.57(95%CI 1.06-2.32), and a similar tendency for stroke (HR 1.42; 95%CI 0.87-2.32). While no associations were observed between noise exposure from any of the sources and incidence of IHD or stroke, there were associations between road traffic and aircraft noise exposure 1-5 years prior to the event and IHD incidence in women, with HR of 1.11(95%CI 1.00-1.22) and 1.25 (95%CI 1.09-1.44) per 10 dB Lden, respectively. On the other hand, a decreased risk of IHD was seen for men in relation to road traffic noise exposure (HR 0.86; 95%CI 0.79-0.94 per 10 dB). **Conclusion** No overall associations were observed between noise exposure from different transportation noise sources and incidence of IHD or stroke. However, there appeared to be an increased risk of IHD in women exposed to road traffic or aircraft noise as well as in those exposed to multiple sources of transportation noise.

#### **O04.01.41. Short-Term Nighttime Wind Turbine Noise and Cardiovascular Events: A Nationwide Case-Crossover Study from Denmark**

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**Abstract:** The number of people exposed to wind turbine noise (WTN) is increasing. WTN is reported as more annoying than traffic noise at similar levels. Long-term exposure to traffic noise has consistently been associated with cardiovascular disease. Effects of short-term exposure are much less investigated due to little day-to-day variation of e.g. road traffic noise. WTN varies considerably allowing investigation of short-term effects of WTN on cardiovascular events. **METHODS AND RESULTS:** We identified all hospitalisations and deaths from stroke (16,913 cases) and myocardial infarction (MI) (17,559 cases) among Danes exposed to WTN between 1982 and 2013. We applied a time-stratified, case-crossover design. Using detailed data on wind turbine type and hourly wind data at each wind turbine, we simulated mean nighttime outdoor (10-10,000 Hz) and nighttime low frequency (LF) indoor WTN (10-160 Hz) over the 4 days preceding diagnosis and reference days. For indoor LF WTN between 10 and 15 dB(A) and above 15 dB(A), odds ratios (ORs) for MI were 1.27 (95% confidence interval (CI): 0.97-1.67; cases = 198) and 1.62 (95% CI: 0.76-3.45; cases = 21), respectively, when compared to indoor LF WTN below 5 dB(A). For stroke, corresponding ORs were 1.17 (95% CI: 0.95-1.69; cases = 166) and 2.30 (95% CI: 0.96-5.50; cases = 15). The elevated ORs above 15 dB(A) persisted across sensitivity analyses. When looking at specific lag times, noise exposure one day before MI events and three days before stroke events were associated with the highest ORs. For outdoor WTN at night, we observed both increased and decreased risk estimates. **CONCLUSION:** This study did not provide conclusive evidence of an association between WTN and MI or stroke. It does however suggest that indoor LF WTN at night may trigger cardiovascular events, whereas these events seemed largely unaffected by nighttime outdoor WTN. These findings need reproduction, as they were based on few cases and may be due to chance.

#### **004.01.42. Influence of Exposure Definition on the Association between Transportation Noise and Myocardial Infarction Mortality**

Danielle Vienneau

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**Abstract:** Epidemiological research on transportation noise uses different exposure assessment strategies including regulatory noise grids or façade point (FP) estimates, with or without knowledge of the residential floor (3rd dimension). FP estimates may further relate to the maximum ("loudest") or minimum ("quiet") exposed dwelling façade. We compared associations between noise exposure and myocardial infarction (MI) mortality considering: FPs vs. noise grids, different assumptions about residential floor, and different spatial scales. Using sonBASE and residential geocodes, we assigned Lden (road and railway noise from FPs) to the 4.41mil adults in the Swiss National Cohort for the: matching residential floor (reference), middle floor, and first floor. We tested spatial scale by calculating mean Lden for each participant using all first floor FPs (or all 10m grid cells) within 50-500m buffers. For the follow-up 2000-2008, we investigated the influence of exposure definition on the association between noise and MI mortality by multipollutant Cox regression models adjusted for socio-demographic confounders and NO<sub>2</sub>. Models using the loudest FPs were robust to assumptions about residential floor. Hazard Ratios (HR) per IQR (dB) were: 1.05 (1.02;1.07) road, and 1.03 (1.01;1.05) railway. Using quiet FPs attenuated the HR for road but not for railway noise. Different patterns were apparent for buffers vs. grids depending on source. HRs for all railway buffers were similar to the reference, while the pattern for road was more erratic with largest attenuation in the 500m buffer. Using grids averaged at different spatial scales generally attenuated the HRs regardless of source. The association between road traffic noise and MI mortality was more sensitive to changes in exposure definition than for railway noise. For both sources, spatial scale seemed more important than residential floor. The use of noise maps to represent residential exposure may underestimate the health effects.

## 004.01H. PFAS and Metabolic Function

### **004.01.43. Are Populations with Low Iodine Intakes More Vulnerable to Thyroid-Disrupting Effects of Perfluorinated Alkyl Acids (PFAAs)?**

Anders Glynn

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Abstract: It has been suggested that populations with a "stressed" thyroid system may be vulnerable to perfluoroalkyl acid (PFAA) exposure (1). We investigated associations between serum PFAA and thyroid hormone (TH) levels (TSH, free T4, free T3) in 10-12 year old children (N=181), and if associations differed according to iodine intake (urinary iodine). PFAAs (12 homologues) and THs were measured in serum by LC/MS/MS and by standard clinical methods, respectively, and urinary iodine by using a modified Sandell-Kolthoff method. Child sex, BMI, nursing, maternal birth country, parental education, number of older siblings, passive smoking, and urine iodine were covariates in multiple linear regressions. Participants were stratified into a low iodine group (urine iodine concentrations (1). Webster GM, et al. 2016. Environ Health Perspect 124, 935-942.

#### **O04.01.44. Exposure to Multiple PFASs during Early Pregnancy and Maternal and Neonatal Thyroid Function**

Emma Preston

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**Abstract:** Background: Prenatal exposure to per- and polyfluoroalkyl substances (PFASs) may disrupt maternal and neonatal thyroid function, which is critical for growth and neurodevelopment. Objectives: To examine associations of prenatal exposure to multiple PFASs with maternal and neonatal thyroid function. Methods: We studied 732 pregnant women and 480 neonates in Project Viva, a longitudinal pre-birth cohort in Boston, MA. We quantified six PFASs including perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS), and maternal thyroid hormones [thyroxine (T4), Free T4 Index (FT4I), thyroid stimulating hormone (TSH)] in plasma collected at a median 9.6 weeks gestation and neonatal T4 levels from post-partum heel sticks. We estimated associations of concentrations of single PFASs with thyroid hormone levels using covariate-adjusted linear regression models and assessed effects of exposure to multiple PFASs using multi-pollutant regression models. Results: PFASs were moderately to strongly correlated (rs: 0.19-0.74). In single-pollutant models, PFASs were not associated with maternal T4 or TSH, but PFOA, PFOS, perfluorohexane sulfonate (PFHxS), and 2-(N-methyl-perfluorooctane sulfonamido) acetate were inversely associated with maternal FT4I [e.g., -1.87% (95% CI: -3.40, -0.31) per interquartile (IQR) increase in PFOA]. Prenatal PFOS, PFOA, and PFHxS were inversely associated with T4 levels in male neonates [e.g. PFHxS, -0.46 µg/dL (95% CI: -0.83, -0.10)]. In multi-pollutant models, PFOA was suggestively inversely associated with maternal FT4I [-1.62% (-3.77, 0.57)]; in neonatal models, PFHxS [-0.36 (-0.75, 0.03)] and PFOA [-0.70 (-1.79, 0.37)] were suggestively inversely associated with T4 levels in males. Conclusions: Prenatal exposure to PFASs was inversely associated with maternal FT4I and T4 in male neonates, with evidence for confounding by PFAS coexposure. These results support the hypothesis that exposure to PFASs may influence maternal and neonatal thyroid function.

#### **O04.01.45. Perfluoroalkyl Substance Mixtures and Gestational Weight Gain among Mothers in the Health Outcomes and Measures of the Environment Study**

Megan Romano

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Abstract: Perfluoroalkyl substances (PFAS) are persistent chemicals often used in the production of consumer goods. Exposure to PFAS are associated with greater adiposity in children and adults, but the association of PFAS with gestational weight gain (GWG) has not been well studied. We quantified perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) concentrations in serum at 18±5 weeks' gestation for 279 women enrolled in a prospective pregnancy cohort (2003-2006, Cincinnati, Ohio) using mass spectrometry. We abstracted weight from medical records to calculate GWG from early pregnancy to delivery and rate of weight gain (GWR) in the 2nd and 3rd trimesters. We used multivariable linear regression to assess associations of GWG and GWR with individual PFAS, adjusted for relevant confounders and weeks' gestation at blood draw. We investigated effect measure modification (EMM) by pre-pregnancy BMI <25 kg/m<sup>2</sup> vs. ≥25 kg/m<sup>2</sup>, and used weighted-quantile-sum (WQS) regression to create a PFAS index to examine the combined effect of the four PFAS. Each 2-fold increase in serum PFOA, PFOS, and PFNA was associated with small and statistically non-significant increases in GWG (range 0.3-0.8 lbs) and GWR (range 0.03-0.06 lbs/week). The association of PFNA with GWG was stronger among women with BMI ≥25 kg/m<sup>2</sup> (β=2 lbs; 95% CI:-2-6) than among those with BMI <25 kg/m<sup>2</sup> (β=-0.5 lbs; 95% CI:-3-2; p-EMM=0.06). Among all women, the PFAS index was positively associated with GWG (WQS β=0.3 lbs; 95% CI: -1.0-1.5) and GWR (WQS β=0.02 lbs/week; 95% CI:-0.03-0.08), though 95% CIs included the null. We did not observe strong evidence of associations between PFAS and GWG in this cohort. Our findings are consistent with one prior study suggesting that PFOA and PFOS are associated with modest increases in GWG. Additional investigation of the association of PFAS with GWG in larger cohorts would be informative to the field.

#### **004.01.46. Exposure to Perfluoroalkyl Substances and Longitudinal Alterations in Glucose Metabolism among Overweight and Obese Hispanic Children: A Metabolomics Approach**

Tanya Alderete

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**Abstract:** Background: Animal studies have shown that early life exposure to perfluoroalkyl substances (PFASs) may disturb glucose metabolism. Human evidence is inconsistent and no previous study has examined the prospective associations between exposure to PFASs and repeated measures of glucose metabolism among Hispanic children. Methods: Overweight and obese Hispanic children (8-14 years) from urban Los Angeles (n=40) underwent clinical measures and 2-hour oral glucose tolerance tests (OGTT) at baseline and follow-up visits (range: 1-3 years). PFASs [perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonic acid (PFHxS)] and untargeted metabolic profiling (~4000 metabolites) of baseline serum samples were measured by high resolution mass spectrometry. Linear regression models were used to assess associations between baseline PFASs and changes in metabolic outcomes over follow-up after adjusting for confounders including age, sex, adiposity and puberty status. Network correlation and cluster analyses identified metabolic responses to PFASs that were characterized by pathway enrichment analysis using Mummichog. Results: Each ln-unit increase in PFOA and PFHxS concentrations was associated with a 26.3 mg/dL (95% CI: 4.9-47.7) and 9.6 mg/dL (95% CI: 1.7-17.6) increase in 2-hour glucose levels, respectively. A ln-unit increase in PFHxS concentrations was also associated with a 18.2 mg/dL increase in the glucose area under the curve (95% CI: 2.6-33.8). Metabolome-wide associations identified 615, 974 and 132 metabolic features associated with PFOA, PFOS and PFHxS, respectively after correcting for multiple comparisons. Pathway analysis showed significant alterations of methionine and cysteine metabolism, hexose phosphorylation, and glycerophospholipid and glycosphingolipid metabolism that were associated with PFASs exposure. Conclusions: This first pilot analysis provides evidence that PFASs exposure may exert diabetogenic effects in Hispanic youth.

#### **O04.01.47. Cross-Sectional Associations of Plasma Per- and Polyfluoroalkyl Substances with Lipid Profile among Pre-Diabetic Adults-Report from the Diabetes Prevention Program**

Pi-I Lin

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Abstract: Per- and polyfluoroalkyl substances (PFASs) may interfere with lipid regulation but most previous studies examined occupational cohorts or general populations but not those with high metabolic risks. Among 957 adults in the Diabetes Prevention Program, we measured plasma concentrations of 6 PFASs and lipoproteins at recruitment (1996-1999) and examined their cross-sectional associations using linear regression adjusting for potential confounding by demographic and lifestyle variables. We excluded 69 participants taking lipid lowering medications or had missing values. Plasma PFAS for the 888 participants were comparable to those reported in NHANES 1999-2000. 59.3% of participants had total cholesterol above 200mg/dL. Median levels of several lipid were higher in the 4th compared to the 1st quartile of summed PFASs. Specifically, median total cholesterol was 4.2% (95% CI: 0.9-7.6%) or 8.5mg/dL higher in the 4th comparing to the 1st quartile; 14.6% (95% CI: 4.7-24.5%) for triglycerides (21.2 mg/dL); 5.9% (95% CI: 1.4-10.3%) for non-HDL (5.9 mg/dL); 6.1% (95% CI: 1.1-11.1%) for HDL/Total Cholesterol ratio (0.3) ; and 14.9% (95% CI: 5.2-24.7%) for vLDL (4.3 mg/dL). We also observed positive associations of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) with total cholesterol, non-HDL, and very low-density LDL (vLDL). We found negative associations for PFOA with LDL particle size and N-ethyl-perfluorooctane sulfonamide acetic acid (EtFOSAA) with HDL. In this pre-diabetic population, higher plasma PFAS levels were cross-sectionally associated with higher blood lipids. Positive associations of PFOS and PFOA with total cholesterol were consistent with previous studies. This study added new findings for EtFOSAA, N-Methyl-perfluorooctane sulfonamide acetic acid, non-HDL, vLDL, and LDL particle size which are clinically relevant lipid parameters.

#### **004.01.48. Perfluoroalkyl Substances and Growth Outcomes through Puberty: Windows of Exposure Susceptibility**

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**Abstract:** Background: Emerging evidence show growth deviations associated with developmental exposure to perfluoroalkyl substances (PFASs), but the existence of exposure windows with increased susceptibility needs clarification. Aim: We evaluated the associations of perinatal, mid-childhood and puberty PFAS exposures with serum concentrations of insulin-like growth factor 1 (IGF1) and body mass index (BMI) through puberty. Methods: We examined 1393 children from two Faroese cohorts born in 1986-1987 (N=851) and 1998-2000 (N=542). PFASs were measured perinatally (cord blood or maternal serum), and in child's serum at ages 7 and 14 years. We calculated z-scores for serum-IGF1 and its binding protein (IGFBP3) at age 7 using sex- and cohort-specific means, and for BMI at ages 7 and 14, using sex- and age- specific means of the CDC Growth Charts. To evaluate differences in the associations between exposure windows, we used multivariable-adjusted generalized estimating equations fitting an interaction term between PFAS and developmental stage. Results: Associations were fairly homogeneous between cohorts (P-cohort int.>0.10 for most comparisons), despite differences in exposure ranges. Boys showed patterns of negative associations that were significant only for mid-childhood PFOS and concomitant IGF1 concentrations ( $\beta$ [95% CI] per PFOS doubling=-0.26 [-0.49,-0.04]), and for PFHxS exposure across all periods and BMI at age 14 ( $\beta$ [95% CI]=-0.09 [-0.17,-0.01]). In contrast, girls mostly showed positive associations that were significant for PFOS exposure across all periods and BMI through age 14 ( $\beta$ [95% CI]=0.08 [0.01,0.16]) and between mid-childhood PFOS, PFHxS and PFDA and IGF1 concentrations (e.g., PFOS:  $\beta$ [95% CI]=0.32 [0.06,0.58]). No clear association patterns were seen for PFOA and PFNA. Conclusion: This study suggests that not only prenatal but also postnatal PFAS exposures are associated with growth through puberty, and associations differ according to the developmental stage and sex.

## S04.01A. Neuroimaging in Studies of Children's Environmental Health

### S04.01.01. Prenatal Polybrominated Diphenyl Ether Serum Concentrations Are Associated with Intrinsic Functional Network Organization and Executive Functioning in Childhood

Erik de Water

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**Abstract:** The prenatal period is a critical time for neurodevelopment and is thus a period of vulnerability during which a range of neurotoxic exposures have been found to exert persistent changes in brain development and behavior. Polybrominated diphenyl ethers (PBDEs), historically used as flame retardants in commercial products, are well-known developmental neurotoxicants. PBDEs were phased out of production a decade ago, but remains measurable in human populations due to their lipophilic properties and continued release from existing consumer products. Despite strong animal and epidemiological evidence of developmental neurotoxicity, the neural substrates linking prenatal PBDE serum concentrations to impaired neurodevelopment are poorly understood. In the present study, we used resting state functional magnetic resonance (fMRI) to examine associations between prenatal PBDEs measured in maternal blood samples and intrinsic functional network organization (i.e., global and local efficiency; measured using a graph-theoretical approach) in 5-year-old children (n = 34). We explored whether PBDE serum concentrations are associated with executive functioning (EF) assessed using a parent-report questionnaire (BRIEF-P) (n = 106) and whether changes in intrinsic functional network organization mediated the association between prenatal PBDE serum concentrations and reported EF problems (n = 34). Children with higher prenatal PBDE serum concentrations showed increased global efficiency of brain areas involved in visual attention (e.g., inferior occipital gyrus) and more reported EF problems. Higher global efficiency of brain areas involved in visual attention was associated with more reported EF problems. Together, these findings suggest that changes in intrinsic functional network organization of visual attention areas may link prenatal PBDE serum concentrations to EF problems in childhood.

## **S04.01.02. Understanding the Associations between Prenatal Dentine Manganese Exposure and Neurodevelopment through the Fusion of Multitask MRI Data**

Yuri Levin-Schwartz

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Abstract: Manganese is a naturally occurring metal that is both an essential nutrient at lower levels and a neurotoxicant at higher levels. Recent studies suggest that higher prenatal manganese exposure results in motor and neurobehavioral deficiencies, demonstrating that the disruption of neurodevelopment during pregnancy by manganese may have long-term consequences for neural function and behavior. However, the neuropsychological tests employed by these studies are unable to quantify the neurophysiological effects that underlie the observed changes. In order to gain a deeper understanding of the impact of prenatal manganese exposure on neural circuitry, we utilize functional magnetic resonance imaging (fMRI) data from two tasks: An N-back (i.e., working memory) task and a finger tapping (i.e., motor) task. The data was gathered from 23 Italian adolescents (aged 15-23 years) and prenatal manganese exposure was assessed using laser ablation inductively coupled plasma mass spectroscopy of deciduous teeth (area under the curve values,  $0.42 \pm 0.19$ ). Since both fMRI tasks are expected to highlight complementary regions associated with prenatal manganese exposure, we exploit a data fusion technique, joint independent component analysis (jICA), to jointly analyze the data, thus enabling greater understanding of the associations between prenatal manganese and subsequent neural function. We find two jICA components suggesting that dentine manganese is positively associated with activation in the somatosensory cortex; a one unit increase in dentine manganese is associated with a 0.35 and 0.26 standard deviation increase in activation of the somatosensory cortex for each component, respectively. These results remain significant after adjusting for multiple comparisons and may suggest inefficiencies in motor control that will be explored using a greater number of subjects and through incorporation of the performance metrics from the tasks themselves.

### **S04.01.03. Prenatal Polybrominated Diphenyl Ether (PBDE) Concentrations and Functional Connectivity of the Reading Network in a Community Sample of 5 Year-Old Children**

Amy Margolis

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**Abstract:** Objective: Examine associations between PBDE concentrations and functional connectivity of the reading network (RN) in a community sample. Method: Resting State fMRI data (rsfMRI) were acquired from 33 five year-olds in a longitudinal birth cohort. Maternal serum PBDE concentrations ( $\Sigma$ PBDE = sum of log concentrations of 4 most frequently detected congeners 47, 99, 100 and 153) were measured at 12.2 $\pm$ 2.8 weeks gestation (mean $\pm$ SD) using isotope dilution high resolution mass spectrometry. Using the CONN toolbox, we assessed connectivity of the RN, and associations between  $\Sigma$ PBDE and network architecture. The RN was defined by 12 regions of interest identified in task fMRI meta-analyses; the graph network was created with a fixed cost threshold (0.15). We evaluated associations between reading ability (Woodcock Reading Mastery Test Word Identification) and  $\Sigma$ PBDE, and graph theoretical output from the RN, controlling for age, sex, verbal IQ, birthweight, and mean motion. Associations between  $\Sigma$ PBDE and Default Mode Network (DMN) architecture assessed specificity of findings. Results: RN regions were significantly intercorrelated ( $t(31)= 5653.7$   $p<.0001$ ), as expected. As prenatal  $\Sigma$ PBDE increased, global efficiency of the RN decreased ( $b=-0.02$ ,  $T=-2.64$ ,  $p=.014$ ). Greater RN global efficiency was associated with better word reading ( $r= 0.399$ ,  $p=0.059$ ).  $\Sigma$ PBDE did not associate with global efficiency of the DMN ( $b -0.00$ ,  $T = -0.43$ ,  $p =.67$ ) or word reading ( $b 0.92$ ,  $T = 0.16$ ,  $p =.87$ ). Conclusion: This is the first rsfMRI study to assess integrity of the RN and associations between prenatal PBDE concentrations and network architecture. Despite being emerging readers, 5-year-old children showed integrity of the functional RN. Increased global efficiency of the RN was associated with better word reading. Additionally, prenatal PBDE concentrations were inversely associated with global efficiency of the RN but not the DMN, suggesting that PBDE may differentially affect RN network integrity.

#### **S04.01.04. Growing Up in Cincinnati: The Neuroimaging Effects of Ubiquitous Environmental Exposures**

Kim Cecil

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**Abstract:** Introduction and Background Researchers in Cincinnati have a long history of studying environmental cohorts. The Cincinnati Lead Study (CLS), a birth cohort initiated in 1979, recruited pregnant women from regions of the city known to have lead hazards with homes constructed prior to the 1940's and positioned near major highways. The Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS) recruited from 2001-2003 using birth records to enroll families with newborns living either within 400 meters of major highways or further than 1 kilometers. From 2003-2006, the Health Outcomes and Measures of the Environment (HOME) study enrolled pregnant women and their offspring to examine common toxicants, including metals, flame retardants, perfluorinated substances and other potential neurotoxicants. We employed multimodal magnetic resonance imaging (MRI) and spectroscopy (MRS) in these cohorts to evaluate the association of selected environmental exposures and neuroimaging outcomes. Methods Participant exposures were characterized throughout childhood. MRI/S evaluations were obtained for the CCAAPS and HOME cohorts at approximately 12 years of age and at several timepoints starting about 21 years of age in the CLS cohort. Results For the CLS, higher mean childhood blood lead concentrations were associated with significant decrements in gray and white matter volumes for several regions, such as the frontal and parietal lobes. Reduced functional activation in Broca's and Wernicke's areas while performing a verb generation task corresponded with higher childhood blood concentrations. However, increased functional activation within the contralateral hemisphere was noted. Conclusions Our data find that environmental exposures influence brain development with structural, organizational and functional alterations revealed by several types of neuroimaging assessments in children and adults.

## **S04.01.05. Early Life Environmental Exposures and Brain Structural Alterations in Childhood**

Monica Guxens

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**Abstract:** Background. Several environmental exposures have been related to impaired child neurodevelopment. However, they mainly used neuropsychological or clinical instruments to evaluate child neurodevelopment, limiting our understanding of which brain structural and functional alterations underlie these associations. We aimed to assess the relationship between several environmental exposures and brain morphology, cortical thickness, and white matter microstructure in children aged 6 to 12 years old. Methods. We used data from the Generation R study, a population-based birth cohort study set up in Rotterdam, The Netherlands (n=9,779, 2002-2006). Several environmental exposures have been estimated during fetal life and childhood including traffic-related air pollution, noise, and organophosphate pesticides. Selected children were scanned at 6-10 years (n=1,070) and the whole cohort was invited to be scanned at the 8-12 years (n=3,992). Structural imaging assessed cortical thickness and volumetric parameters. Diffusion tensor images assessed white matter microstructure. Results. Higher fetal particulate matter levels were related to thinner cortex in several brain regions at 6-10 years old (e.g. cerebral cortex in the precuneus region was 0.045mm thinner (95%CI 0.028-0.062) for each 5µg/m<sup>3</sup> increase in PM<sub>2.5</sub>). The reduced cerebral cortex in some brain regions partially mediated the association between PM<sub>2.5</sub> and impaired inhibitory control. Higher fetal exposure to PM<sub>2.5</sub> absorbance and childhood exposure to NO<sub>x</sub>, oxidative potential of PM<sub>2.5</sub>, and zinc content of PM<sub>2.5</sub> were associated with white matter alterations at 8-12 years old. No relationship was found between fetal noise exposure and white matter microstructure. Conclusions. The use of MRI is gaining ground, making it possible to identify the structural and functional brain alterations that underlie the associations between environmental exposures and children's neurodevelopment in a non-invasive way.

S04.01B. The Impact of Long-Range Wildfire Smoke Plumes on Air Quality and Health  
**S04.01.07. Fine Particulate Matter from Wildfires and Risk of Hospital Admissions in the Western United States**

Michelle Bell

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Abstract: Wildfire can dramatically increase the levels of fine particulate matter (PM<sub>2.5</sub>) in affected areas, resulting in potential health risks. As air monitors cannot separate the PM<sub>2.5</sub> specifically from wildfires from those from other sources and have limited spatial and temporal resolution, new methods are needed to assess the health impact of wildfire-specific PM<sub>2.5</sub>. Further, this pollutant has a unique "high-and-rare" frequency distribution. We estimated the wildfire-specific PM<sub>2.5</sub> at the county level in the Western US during 2004-2009 using the GEOS-Chem model based on Global Fire Emissions Database, and created a new concept called a "smoke wave" (days of high PM<sub>2.5</sub> from wildfire smoke) to systematically quantify the frequency, length, and intensity of wildfire smoke events for 369 US counties. We found that an average Western US county experienced 4-5 smoke wave days/year, and the average smoke wave intensity was 33 micrograms/m<sup>3</sup>. Linking county-level wildfire-specific PM<sub>2.5</sub> to county-level Medicare hospital admission data, we found that intense wildfire smoke episodes are associated with a 7.2% (95%: 0.25%, 15%) increase in respiratory admission rates among Medicare populations in the Western US. The results implied potentially severe health impact of wildfire smoke, a growing threat in the Western US under the impact of hotter and drier summers due to climate change.

#### **S04.01.08. Health Impacts Associated with Fine Particulate Matter and Ozone during a Wildfire: Evidence of Differential Effects Due to Measures of the Social Environment**

Colleen Reid

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Abstract: Wildfires have been increasing in frequency in the western US with the 2017 fire season experiencing some of the worst wildfires in terms of suppression costs and air pollution that the western US has seen. Although there is growing evidence of respiratory exacerbations from elevated fine particulate matter (PM<sub>2.5</sub>) during wildfires, significantly less is known about the impacts of ozone from wildfires on human health. Using machine learning, we created daily surface concentrations maps for PM<sub>2.5</sub> and ozone during an intense wildfire in California in 2008. We then linked these daily exposures to counts of hospitalizations and emergency department visits at the ZIP code level during the wildfire period. We calculated relative risks of respiratory and cardiovascular health outcomes using Poisson generalized estimating equations models for each pollutant in separate and mutually-adjusted models, additionally adjusted for pertinent covariates. We additionally investigated effect modification by various measures of socio-economic status, and racial diversity by ZIP code. We found that PM<sub>2.5</sub> was significantly associated with exacerbations of asthma and chronic obstructive pulmonary disease (COPD) and that these effects remained after controlling for ozone. Effect estimates of ozone during the fires were non-significant. In general, we found that asthma was significantly associated with PM<sub>2.5</sub> during wildfires in ZIP codes in all levels of various socio-economic variables, however, we found significant relationships for COPD for more economically disadvantaged ZIP codes, and for ZIP codes with lower levels of concentrated immigration and with moderate (as compared to lower and higher) levels of racial diversity. Understanding differential risk of health impacts from wildfire smoke is increasingly important as wildfires are contributing more to our air pollution exposures, particularly in western North America.

### **S04.01.09. Impact of Long-Range Wildfire Smoke Plumes on Air Quality in New York City over the Past 10 Years**

Beizhan Yan

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Abstract: Hundreds of wildfires burn through the western US and Canada every year in recent decades. Climate change is increasing the prevalence and severity of wildfires, resulting in longer fire seasons and larger area burned. Large wildfires can inject smoke kilometres into the troposphere, where it can be transported in plumes for long distances, even on continental scales. Depending on their height and atmospheric dynamics, plumes can either pass over cities above the boundary layer with little to no effect on local air quality or subside into the planetary-boundary-layer (PBL) and mix with surface air, impacting local air quality. Evidence has shown that the adverse health effects (e.g., a significant increase in mortality and hospitalization rates for respiratory outcomes) were associated with smoke exposure in impacted areas both close to and far away from the fires. In this study, local LiDAR data, EPA AirNow hourly polluted data, and IMPROVE daily data were combined to investigate the impact of wildfire smoke plume on local air quality in NYC. Thirty events (from 2007 to 2016) were first determined by HMS smoke and fire product and local LiDAR profile. Based on plume height, HYSPLIT back-trajectory was used to track whether the plumes were originated from the wildfire regions. Through this study we found that 1) LiDAR can unambiguously identify the mixing of plume with local air in NYC; 2) Wildfire smoke plumes impacts NYC about 3 to 6 times a year, totaling a duration of 20 to 30 days. Plume contributes about 10 to 20% of total PM<sub>2.5</sub> in NYC; 3) During these events, PM<sub>2.5</sub> can reach to 40 to 60 µg/m<sup>3</sup> for several days, above the 35 µg/m<sup>3</sup> NAAQS standard; 4) Plumes contain elevated levels of PM, EC, iron, soil components, ammonium sulphate, etc., some of which can lead to adverse health effects.

#### **S04.01.10. Satellite-Based Daily PM<sub>2.5</sub> Estimates during Fire Seasons in Colorado**

Guannan Geng

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**Abstract:** The Western United States has experienced increasing wildfire activities, which have negative effects on human health. Epidemiological studies on wildfire PM<sub>2.5</sub> are limited by the lack of high-resolution PM<sub>2.5</sub> exposure data over fire days. Satellite-based aerosol optical depth (AOD) data provides additional information in ground PM<sub>2.5</sub> concentrations and has been widely used in previous studies. However, the low background concentration, complex terrain and large wildfire sources add to the challenge of estimating wildfire PM<sub>2.5</sub> concentrations. In this study, we applied a Bayesian ensemble model that combined information from the 1 km resolution AOD products, CMAQ model simulations and ground measurements to predict daily PM<sub>2.5</sub> concentrations over fire seasons in Colorado for 2011–2014. Our model had an out-of-sample R<sup>2</sup> of 0.66 and cross-validated root-mean-squared error of 2.00 µg/m<sup>3</sup>. Elevated PM<sub>2.5</sub> concentrations over large fire events were successfully captured. The modeling technique demonstrated in this study could support future short-term and long-term epidemiological studies of wildfire PM<sub>2.5</sub>.

#### **S04.01.11. Forecasting Air Pollution in Australia from the Long-Range Transport of Wildfire Smoke and Prescribed Burns**

Martin Cope

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Abstract: Wildfires are a frequent occurrence in Australia, caused by lightning strikes, power line failures or human interventions. Prescribed burning is one of the principal tools used to mitigate the frequency and intensity of wildfires. Prescribed burning is also extensively used for landscape management- particularly in the Northern Territory of Australia. However, the smoke from wildfires and prescribed burning also has the potential to significantly impact regional and urban air quality and population health, and thus it is important to include this consideration when managing ambient fires. Smoke transport is not constrained by state boundaries and there are many examples in Australia where regional transport has led to over-the-horizon impacts of smoke from remote sources. This is challenging for state-based land management agencies who are tasked with undertaking prescribed burns within the constraint that the combined (all sources) air pollution downwind of a burn has a minimal impact on an exposed population. The Australian Bureau of Meteorology has recently commenced daily forecasts of air pollution (with an emphasis on smoke) using AQFx, a multi-tiered system which includes a numerical air quality forecasting model. AQFx generates 24-72 hour forecasts over a domain which spans Australia and focuses on Victoria and Tasmania, two of the eastern states, with a population of over 4 million people. In this presentation we will explore case studies where AQFx forecasts and observations indicate that significant regional transport of smoke from wildfires or prescribed burns has occurred. We will highlight cases of population responses to the smoke exposure and consider how the use of regional air quality forecasting may be used to mitigate the impact of over-the-horizon smoke transport events on affected populations.

#### **S04.01.12. Characterizing the Level and Distribution of Wildland Fire Smoke Impacts in the U.S. among Susceptible Populations**

Neal Fann

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Abstract: Wildland fires are a significant source of fine particles (PM<sub>2.5</sub>) in the atmosphere. Previous research has explored the air quality and human health impacts of wildland fire events over a multi-year period in the United States. Less well understood is how wildland fires affect populations most susceptible and vulnerable to poor air quality. In this analysis, we characterize the wildland fire-attributable exposure and PM<sub>2.5</sub> related mortality and morbidity impacts among several subpopulations between 2008 and 2012. Following approaches previously employed in the literature, we operationalize the terms susceptible and vulnerable according to a variety of attributes that can be observed at the population-level; these include age, race, ethnicity and baseline rate of mortality and morbidity. We also draw from approaches used within the Environmental Justice literature-the Gini Coefficient and Atkinson Index in particular-to quantify the level of mortality and morbidity risk inequality within susceptible and vulnerable groups and between these groups and the rest of the population affected by wildland smoke. We explore the extent to which the extent and intensity of wildland fire events are associated with greater or lesser risk inequality among these subgroups over this five-year period.

## O04.02A. Building Ventilation and Indoor Air Quality: Monitoring, Intervention, Risk Assessment, and Benefits Analysis

### O04.02.01. Continuous Monitoring of PM2.5 in Finnish Office Buildings

Samy Clinchard

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Abstract: Indoor air quality (IAQ) parameters including temperature, relative humidity, carbon dioxide (CO<sub>2</sub>), volatile organic compounds (VOCs), and particulate matter (PM) concentrations are monitored continuously (15 s interval) in the breathing zone of Finnish office buildings (average five rooms per building). A general goal is to develop IAQ monitoring and analytics supporting building owners' decisions from the point of view of occupants' health and productivity. This study focuses on PM<sub>2.5</sub> monitoring during 10/2016-3/2018 in 73 buildings: 1) 53 from Helsinki metropolitan area and 2) 20 from other areas. The monitoring was conducted with PM probes using laser diffraction technology (light scattering) with 1µg/m<sup>3</sup> resolution and 0-950 µg/m<sup>3</sup> range. In addition, hourly outdoor PM<sub>2.5</sub> data provided by Finnish Meteorological Institute or Breezometer are used in the analyses. Both 24h and 8h (occupied period) averages for indoor PM<sub>2.5</sub> concentrations were < 1 µg/m<sup>3</sup>, whereas outdoor concentrations were about 6 µg/m<sup>3</sup>. All buildings use mechanical ventilation, typically involving filtration of supply air. Without knowing the filter types, the theoretical average reduction from the outdoor levels is about 89% in the metropolitan area, which could be obtained with filters with MERV rating of 12-14. In the other (than metropolitan) areas, indoor concentrations were consistently lower throughout the monitoring period: An average reduction of 96% could be obtained with MERV 14-16. Other possible explanations for low indoor concentrations include high ventilation and air tightness of the building envelope. In reality, there are always some unfiltered air entering indoors, and also indoor sources exist. Recognizing the limitations related to indoor PM detection methodology, we will report temporal variations in indoor PM<sub>2.5</sub> concentrations, as well as the effects of ventilation and building characteristics on the particle infiltration in this relatively large sample of office buildings.

## **O04.02.02. Environmental Interventions in Primary Schools and Its Impacts on Indoor Air Quality and Student Health**

Nan Yan

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**Abstract:** Background: Deficient indoor environmental quality (IEQ) in schools could adversely affect the performance and physical health of students and teachers. Ventilation rate and particle filtration are two key factors that influence IEQ. Aims: We present the design and selected results of an intervention study conducted in two schools with 2nd to 4th grade students. We describe a number of innovative outcome measures for both academic performance and physical fitness. Methods: We conducted a blinded case-crossover trial of two interventions, increased ventilation rates and advanced particle filtration, in two primary schools. The school year was divided into five periods; a baseline period and four intervention periods, during which one-half of the classrooms was the treatment group; the other half was not. In each period, we measured IEQ parameters, e.g., optical particle counts (OPC), particulate matter (PM) concentrations, air change rates, volatile organic compounds (VOCs), in four classrooms in each school. Outcome measures, obtained on 629 students, included absenteeism, curriculum-based tests in several academic areas, and the progressive aerobic capacity endurance run (PACER) tests, which measures the cardio-respiratory endurance/aerobic capacity. Results: Interventions altered PM concentrations but did not appear substantially change estimated ventilation rates. We found that the PACER fitness scores varied little between treatment and control groups across intervention periods, but longitudinal analyses showed several changes. The interventions did not appear to alter absenteeism. Results for the two schools differed, possibly reflecting the ability to successfully implement interventions. Conclusions: The study suggests the potential of intervention studies in schools for identifying strategies that benefit indoor air quality and students' physical health, and suggests the need to control for time varying factors that may influence outcomes.

### **004.02.03. Quantifying the Impact of Energy-Efficient Housing Interventions on Indoor Air Quality and Energy Consumption Using Energy, Airflow, and IAQ Co-Simulation**

Lindsay Underhill

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**Abstract:** **BACKGROUND.** Residential weatherization retrofits can provide important economic benefits to low-income residents, but can also impact indoor air quality (IAQ). Mechanical ventilation can mitigate IAQ impacts, but can lead to higher energy costs. Furthermore, the combined impact of these measures across diverse multifamily environments has not been well-established. Simulation models provide an efficient means of evaluation, but to date modeling studies have focused on either IAQ or energy without comprehensively evaluating IAQ-energy tradeoffs. **METHODS.** We use a novel co-simulation model of CONTAM and EnergyPlus to simulate the impacts of minimum and high-performance weatherization and ventilation standards on indoor PM<sub>2.5</sub>, gas consumption, and electricity utilization in typical midrise multifamily buildings in the U.S. Unlike previous energy- or IAQ-only models, our co-simulation model can account for the interdependencies between heat transfer, airflows, and contaminant transport in multifamily buildings. We simulated 648 factorial combinations of weatherization (insulation and sealing), ventilation (exhaust and supply ventilation, local cooking exhaust, and HVAC filtration), and indoor PM<sub>2.5</sub> sources (cooking, smoking, infiltration) to identify IAQ-energy "win-win" scenarios as well as scenarios with IAQ-energy tradeoffs. **DISCUSSION.** We found that IAQ and energy impacts varied by retrofit performance level, mechanical ventilation, indoor sources, and weather. Combined weatherization and ventilation measures meeting minimum standards generally led to energy savings (ranging from 15% to 45%) and reductions in total indoor PM<sub>2.5</sub> (ranging from -1 µg/m<sup>3</sup> to -29 µg/m<sup>3</sup>). Meanwhile, some retrofit combinations exceeding minimum standards led to IAQ disbenefits for heavy cooking or smoking homes or an increase in energy costs due to added supply ventilation. Results demonstrate the utility of our model in identifying interventions that provide both energy and IAQ benefits.

#### **O04.02.04. Energy Savings, Emission Reductions, and Health Co-Benefits of the Green Building Movement**

Piers MacNaughton

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**Abstract:** Buildings consume nearly 40% of primary energy production globally. Certified green buildings substantially reduce energy consumption on a per square foot basis; however, the co-benefits to health through reductions in energy use and concomitant reductions in air pollution from fossil fuel power plants have not been examined. We calculated year by year LEED (Leadership in Energy and Environmental Design) certification rates in six countries (United States, China, India, Brazil, Germany and Turkey) and then used data from the Green Building Information Gateway (GBIG) to estimate energy savings in each country each year. Of the green building rating schemes, LEED accounts for 32% of green certified floor space and publically reports energy efficiency data. We employed Harvard's Co-BE Calculator to determine pollutant emissions reductions by country accounting for transient energy mixes and baseline energy use intensities. Co-BE applies the social cost of carbon and the social cost of atmospheric release to translate these reductions into health benefits. Based on modeled energy use, LEED-certified buildings saved \$7.5B in energy costs and averted 33MT of CO<sub>2</sub>, 51kt of SO<sub>2</sub>, 38kt of NO<sub>x</sub> and 10kt of PM<sub>2.5</sub> from entering the atmosphere, which amounts to \$5.8B (lower limit = \$2.3B, upper limit = \$9.1B) in climate and health co-benefits from 2000 to 2016 in the six countries investigated. The U.S. health benefits derive from avoiding an estimated 172-405 premature deaths, 171 hospital admissions, 11,000 asthma exacerbations, 54,000 respiratory symptoms, 21,000 lost days of work, and 16,000 lost days of school. Because the climate and health benefits are nearly equivalent to the energy savings for green buildings in the U.S., and up to ten times higher in developing countries, they provide an important and previously unquantified societal value.

#### **O04.02.05. Variability in Ambient Air Pollution Infiltration and Its Impact on Personal Exposure**

Wenwei Che

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Abstract: More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the World Health Organization (WHO) limits. Air pollution is identified as the biggest environmental risk to health by the WHO. To better response to the adverse health effect from air pollution, it's important to understand people's contact with air pollutants in their daily life. Over the past three years, we have carried out a range of exposure measurements in Hong Kong. Concentrations of fine particulate matter (PM<sub>2.5</sub>) and gases (CO, CO<sub>2</sub>, O<sub>3</sub>, NO, NO<sub>2</sub>) were measured using portable air quality monitors in several microenvironments including schools, offices, homes, shopping malls and popular transportation modes, such as the Mass Transit Railway (MTR) subway system, transit buses, trams and minibuses. The results demonstrate substantial variations in exposure concentration among microenvironments, affected by the differences in ventilation systems and ventilation practices, diversity in local emissions, and heterogeneity in outdoor concentrations caused by complex urban morphology, such as street canyons and high-rise buildings. High correlations were found between outdoor and indoor air pollution for microenvironments with natural ventilation, or mechanical ventilation with simple filters. Exposure to PM<sub>2.5</sub> was found to be 2-5 times higher at places with Aluminum filter than those with a HEPA filter. PM and gas concentration measured at some of the transportation modes were highly correlated with outdoor concentrations which may be associated with the proximity of their air intakes to the roadside air pollution. Preliminary 24-h personal exposure measurements suggest that microenvironments with high infiltration from outdoor air pollution contribute substantially to the total exposure throughout the day. The collected data and results will aid in developing estimates of human exposure and designing air pollution exposure management strategies.

#### **O04.02.06. Tightening Standards for Indoor Levels of PM2.5: A Promising Approach for Reducing PM2.5 Associated Mortalities in Urban China**

Yinping Zhang

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**Abstract:** Outdoor PM<sub>2.5</sub> pollution in China has been estimated to cause more than one million premature mortalities annually. In urban areas residents spend a major fraction of their time indoors, meaning that a large fraction of urban exposure to "outdoor PM<sub>2.5</sub>" occurs indoors. This study estimates premature adult mortalities attributed to PM<sub>2.5</sub> across urban China in 2015 and the corresponding mortality reductions achieved by meeting the yearly-averaged indoor PM<sub>2.5</sub> threshold in the newly established Assessment Standard for Healthy Building (ASHB) and seven other potential thresholds. We use outdoor PM<sub>2.5</sub> concentrations from 1497 monitoring sites in 366 cities in China, coupled with a detailed exposure model, to estimate outdoor and indoor exposures to PM<sub>2.5</sub> originating outdoors. We proceed to calculate premature mortality attributable to PM<sub>2.5</sub> exposure using an integrated exposure-response model. Results indicate that indoor exposures accounted for 66%-87% of total exposure to PM<sub>2.5</sub> of outdoor origin and 76% (248,174) of the 328,362 premature mortalities attributable to "outdoor PM<sub>2.5</sub>" for the urban population ≥25 years of age in China in 2015. Stroke, ischemic heart disease, chronic obstructive pulmonary disease, and lung cancer mortalities attributable to indoor exposure were 132,209, 71,960, 24,233 and 19,773, respectively. Potentially 10,172 deaths could be avoided if indoor PM<sub>2.5</sub> of outdoor origin met the current ASHB standard of 35 µg/m<sup>3</sup> as annual mean, and 113,219 deaths could be avoided by meeting a 10 µg/m<sup>3</sup> threshold. The findings demonstrate the effectiveness of reducing indoor exposures to "outdoor PM<sub>2.5</sub>" in reducing premature mortalities attributable to urban PM<sub>2.5</sub> pollution in China. Estimates of mortality reductions associated with various indoor PM<sub>2.5</sub> thresholds can help formulate indoor air quality policies and practices, including building- or room-based filtration of ventilation air.

## 004.02B. Effects of Temperature 2

### **004.02.07. Interactive Effects of Air Pollution and Air Temperature on Preterm Delivery in 24 Major Cities across Canada**

Eric Lavigne

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**Abstract:** Background: Epidemiological studies have reported associations between preterm birth and short-term exposure to ambient air pollution and air temperature. However, it remains uncertain whether there are interactive effects of air pollution and temperature on risk of preterm birth. We investigated whether short-term associations of ambient air pollution were modified by air temperature and whether air pollution levels affected the temperature-preterm birth associations in 24 major cities across Canada. Methods: We first analyzed air temperature-stratified associations between air pollution and preterm birth as well as air pollution-stratified temperature-preterm birth associations using city-specific Cox proportional hazards models with a distributed lag nonlinear temperature term in each city. All models were adjusted for individual-level confounders. City-specific effect estimates were then pooled using random-effects meta-analysis. Results: Pooled associations between air pollutants and risk of preterm delivery were overall positive and generally stronger at high relatively compared to low air temperatures. For example, on lag-0 (i.e. same day of preterm delivery) with high air temperatures (>75th percentile), an increase of 7.4  $\mu\text{g}/\text{m}^3$  in PM<sub>2.5</sub> corresponded to a 2.51% (95% CI: 0.39%, 4.67%) increase in preterm delivery, which was significantly higher than that on days with low air temperatures (<25th percentile) [-0.18% (95%CI: -0.97%, 0.62%)]. On days with high air pollution (>50th percentile), both heat- and cold-related preterm delivery risks increased. Conclusion: Our findings showed that the association between preterm delivery and air pollution was modified by air temperature and vice versa. Our findings point to the importance of understanding the combined health effects of ambient air pollution and air temperature.

## **004.02.08. Regional Evidence-Based Extreme Cold Warning Thresholds Using Daily Mortality Data**

Sabit Cakmak

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**Abstract:** Background: During cold-weather spells, weather warnings are issued to the public by local public health units or meteorological departments. Generally, these cold warnings do not rely on epidemiological evidence or on the association between health outcomes and meteorological variables. This study was done in response to a joint request from the Climate Change and Health Office of Health Canada and Environment and Climate Change Canada to develop a data-driven scheme to improve the current cold-health warning system. Objective: This study aimed to use a systematic data-driven approach to improve current cold-health warning systems by modeling the relationship between extreme cold and excess risk of mortality in a regional context. Our specific objective was to relate winter daily maximum temperature to cause-specific mortalities in order to identify extreme cold thresholds that are significantly associated with excess mortality. Methods: Cluster analysis was used to identify meteorological regions. Maximum temperature with lag 0 was chosen as the indicator, and warning thresholds were obtained in order to minimize excess acute myocardial infarction and cerebrovascular disease mortalities. Data recorded between 1981 and 2010 in the province of Manitoba, Canada was used to test the methodology developed in this study. Results: Two main meteorological regions in Manitoba were identified. Regional warning thresholds of winter daily maximum temperatures were obtained. These thresholds were -23 and -28 for the southern and northern regions, respectively. Conclusion: Our study is a first step in providing an information base to develop a data-driven regional cold-weather warning system in Manitoba. The approach presented in this paper is flexible and has the capacity to be applied to other provinces in Canada.

## **O04.02.09. The Role of Humidity in Associations of High Temperature with Mortality: A Multi-City Multi-Country Study**

Ben Armstrong

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**Abstract:** There is strong experimental evidence that physiologic stress from high temperatures is greater if humidity is higher. However, "heat indices" developed to allow for this have not consistently predicted mortality better than has (dry-bulb) temperature. To clarify, we explored models for daily mortality as a function of both temperature and humidity in a large international dataset. **Methods.** In each of 395 cities in 17 countries we fitted a time series regression model to summer mortality with distributed lag non-linear model (DLNM) for temperature (to lag 3) and supplemented this with a range of terms for relative humidity and its interaction with temperature. City-specific associations were summarised using meta-analytic techniques. **Results.** There was significant variation in the association between cities and countries, with the overall association of humidity with cumulative lag0-3 mortality close to null. At very high temperatures risk did on average rise slightly with high humidity. For example, on average at 99th centile summer temperature (Vs MMT) increase=13.6% at median humidity and 0.8% higher (95%CI 0.1-1.5) at 99th centile humidity. In contrast, below the 90th centile temperature the 99th centile humidity increment was null 0.0%(-0.1,0.2). The humidity-related excess risk was overwhelmingly at lag 0, with high humidity at lag 1 usually associated with LOWER mortality, possibly reflecting an increased risk with upward change in humidity between lags 1 and 0. Results using dewpoint were very similar. **Discussion.** In general, allowing for humidity in addition to temperature added only marginally to ability to predict daily summer mortality in a city in models considering lags 0-2, with risk increments for higher humidity restricted to periods of very high temperature. However, in specific countries or cities atypical for this data set, or for different lag intervals, patterns may be different. On behalf of the MCC Collaborative Research Network.

#### **004.02.10. Increased Impulsivity in Urban-Dwelling Teens: Role of Ambient Air Temperature and Lack of Neighborhood Greenspace**

Diana Younan

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**Abstract:** Ambient temperature and lack of residential greenspace have been associated with increased externalizing behavior, but the neuropsychological processes are unclear. We conducted a longitudinal analysis to examine the association between temperature, greenspace, and impulsivity in urban-dwelling adolescents. Participants (N=982) of the Risk Factors for Antisocial Behavior Study, a multi-ethnic cohort of Southern California twins/triplets examined in 2000-2014 (aged 9-21 years), each with repeat measures of impulsivity assessed by the Go/No Go test. Ambient temperature near the residence (6.8±3.0 km) were obtained from local Meteorological Information System and Normalized Difference Vegetation Index was used as a proxy for neighborhood greenspace (in 1000-m buffer). A monthly exposure time-series was created and aggregated in short-term (1-, 3-, and 6-month) and long-term (1-, 2-, and 3-year) averages prior to each behavioral assessment. Generalized Poisson mixed models were used to estimate the exposure effects on number of false alarms, adjusting for within-family/-individual correlations and confounders. In separate adjusted analyses, we found average temperature from 1-month to 2-years significantly (all p<0.05) increased impulsivity, while long-term greenspace decreased impulsivity. In models mutually adjusting for temperature and greenspace, the neurotrophic benefits of greenspace disappeared, while the adverse effects of 1- and 3-month temperature remained. These associations could not be explained by sociodemographics, neighborhood quality and socioeconomic characteristics, or season. This is the first epidemiologic evidence supporting the adverse temperature effects on impulsivity, which may contribute to the behavioral effect of diminished greenspace. Future studies need to examine whether increased impulsivity mediates the adverse behavioral effect and how neural networks underlying such neuropsychological processes are perturbed by ambient temperature.

## **O04.02.11. Ambient Temperature and Preterm Birth: A Retrospective Observational Study of 30 Million U.S. Singleton Births**

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**Abstract:** Background: Emerging evidence suggests that prenatal exposure to temperature extremes may be associated with higher risk of preterm birth, but prior studies have been limited by small sample sizes and the results have been heterogeneous. We examined the associations between daily and trimester-mean ambient temperature during pregnancy and preterm birth in the contiguous United States. Methods: We linked 30,326,344 singleton births in 403 US counties between 1989 and 2002 to daily ambient temperature at the county level. Births delivered prior to 37 completed weeks of gestation were considered preterm. We used distributed lag non-linear time-series models to estimate the association of preterm birth with daily temperature in the 2 weeks prior to delivery, and logistic regression to assess the association between preterm birth and average temperatures in the 1st and 2nd trimester. Results: Approximately 2.7 million (9.0%) deliveries were preterm. Extreme heat (99th percentile versus median of county-specific temperatures) in the 2 days prior to delivery was associated with an incidence rate ratio (IRR) of preterm birth of 1.038 (95% CI: 1.027, 1.050) while extreme cold (1st percentile versus median) was associated with an IRR of 0.984 (0.974, 0.994). Warm average temperatures (>90th percentile of county- and trimester-specific temperature distributions versus milder temperatures) during the 1st and 2nd trimester were associated with higher relative risk of preterm birth, with odds ratios of 1.025 (1.019, 1.032) and 1.016 (1.009, 1.023), respectively, while cold average temperatures (<10th percentile) were associated with lower relative risks of preterm birth. Conclusions: Extreme heat - but not cold - during the 3rd trimester may be associated with triggering of preterm birth in the US. Warmer average temperatures in the 1st and 2nd trimesters may also be associated with higher relative risk of preterm birth. Heat may be a novel risk factor for preterm birth in the US.

## **004.02.12. Evaluation of a Smart Phone Application Providing Citizen Services during Extreme Temperature Events: The Treasure and Extrema Projects**

Klea Katsouyanni

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"Abstract: Background/Aim: The health effects of extreme temperatures are well documented at population level. Within the TREASURE project, a smartphone application developed to provide services to citizens during heatwaves in Athens is being scaled-up, within the EXTREMA project, to cover several European cities and cold spells. We report here an evaluation of the first application and the plan for further evaluations. Methods: Forty seven volunteers, age range 22-69 years, recruited in July 2016, followed a protocol for using the mobile app during one week. The app returned a heat-related risk in four categories based on personal risk profile and satellite-derived real time temperature at the specific location of the subject. In case of "high risk", instructions for protective measures and guidance for reaching air conditioned municipal sites were provided. The volunteers used the app  $\geq 7$  times/day, recorded the response, temperature and relative humidity indications, and noted the instructions that they followed. They also kept a time-activity diary (TAD) and wore a portable thermometer recording ambient temperature every 5'. Results: A high risk indication was returned 141 times for 18 individuals during 9 different days. Ten subjects reported following instructions for risk reduction. The locations based on the TAD were classified as "home"; "outdoors"; "in transportation"; "indoors" and "at the beach". The highest temperatures were recorded at the beach (32.6°C), followed by "in transportation" (30.5°C). Conclusions: The application was found useful for citizens in Athens during the summer. The problem that often elderly individuals are not using a smart phone may be addressed by supporting multiple profiles in the app by their relatives or using the Municipality public announcement boards. An evaluation with subjects having chronic respiratory diseases and the extension for cold spells is planned. \*TREASURE and EXTREMA projects are co-funded by the European Commission, DG-

## O04.02C. Global Trends in Human Biomonitoring

### **O04.02.13. German Environmental Specimen Bank: Urine Samples from 1999-2017 Document Rapid Increase in Exposure to the Para-Phthalate Plasticizer DEHTP**

Frederik Lessmann

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**Abstract:** Di(2-ethylhexyl) terephthalate (DEHTP) is increasingly used as an alternative to reprotoxic ortho-phthalate plasticizers, e.g. di(2-ethylhexyl) phthalate (DEHP), in everyday products such as food contact materials, toys and medical devices. In Western Europe, DEHTP consumption rose from 2,000 t in 2002, to 100,000 t in 2014 and a predicted 135,000 t in 2019. To investigate for possible increases of DEHTP exposure in the German population over time, we analyzed 600 24-hour urine samples of the German Environmental Specimen Bank for specific DEHTP metabolites as exposure biomarkers. Samples were collected in the years 1999-2017 (ten sampling years, 30 male and 30 female volunteers each, aged 20-29). The samples were blinded and randomized before analysis. Four urinary DEHTP metabolites (side-chain oxidized monoesters) were determined by online SPE LC-MS/MS with isotope dilution quantification. The limits of quantification were 0.2 µg/L (5cx-MEPTP and 5oxo-MEHTP), 0.3 µg/L (5OH-MEHTP) and 0.4 µg/L (2cx-MMHTP). From 1999 until 2009 the main oxidized DEHTP metabolite 5cx-MEPTP was rarely detected. Afterwards, detection rates increased significantly (8% in 2009, 42% in 2011, 95% in 2013, 98% in 2015, and 100% in 2017). The median concentration for 5cx-MEPTP increased from For the first time, we document the increasing exposure to DEHTP of the German population in a robust set of 600 24-hour urine samples collected between 1999 and 2017. Although considered uncritical for now, the steep increase in DEHTP exposure calls for a continued exposure monitoring.

#### **O04.02.14. Human Exposure to Mercury during the Last Half-Century: Worldwide Trends in Human Blood and Breast Milk Levels and Their Implications on Health**

Brij Sharma

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Abstract: Mercury is a pollutant of global concern. It has been found in various biological media including human blood and breast milk, globally. This study assesses global and regional trends of mercury levels in human blood and breast milk in the last half-century. This study also provides an overview of epidemiological literature showing evidence of associations between mercury exposure and various human health conditions. We searched electronic databases to identify articles published prior to June 14, 2017. Our search finalized a pool of 562 studies reporting total mercury levels in whole blood, cord blood, or breast milk and associations with human health conditions. Temporal trends of mercury levels in target media were estimated using a linear fit of the log-transformed data. Choropleth maps were created to provide an overview of worldwide mercury levels in human blood and breast milk. Furthermore, a summary of significant and relevant associations between mercury exposure and human health conditions in children and adults was prepared. We found significant declines in mercury levels in whole blood, cord blood, and breast milk between 1966-2015. A regional overview of mercury exposure suggests highest levels in South America, followed by Africa and Asia. Populations from North America and Europe were found with the lowest mercury exposure levels. We observed conclusive consistent associations of mercury exposure with only selected health conditions, especially neurodevelopment and neurotoxicity in children and adults. For several other health conditions, reported findings do not support conclusive associations. Our study establishes a baseline for the evaluation of mercury levels and health risks that will be measured under the Minamata Convention in the future and highlights the demand for well-designed epidemiological investigations to fully understand the health implications of mercury exposure.

#### **004.02.15. Relationship between AHR Genetics and Dioxin Half-Life in Seveso Women**

Jennifer Ames

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**Abstract:** Background: Biological half-lives of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), an endocrine-disrupting and carcinogenic compound, are long but vary widely in humans (typically 4-10 years) with factors such as dose, age, BMI, and smoking known to play a role. The contribution of genetic variation in the aryl hydrocarbon receptor (AHR), a transcription factor integral to xenobiotic metabolism, remains poorly understood but could have important implications for health. Methods: The Seveso Women's Health Study (SWHS), initiated in 1996, is a cohort of 981 Italian women exposed to TCDD from an industrial explosion in July 1976. We calculated apparent TCDD elimination half-life in a subset of women (n=263) for whom we measured TCDD in blood from two time points: 1) immediately following the accident in 1976 and 2) at study enrollment in 1996. We genotyped 19 single nucleotide polymorphisms (SNPs) across the AHR gene. The relationship between individual SNPs and TCDD half-life was examined with robust multivariate regression, adjusting for other half-life predictors. Results: In our sample, the median (range) of TCDD half-life was 5.2 (1.9-22.0) years. We found two AHR SNPs significantly associated with biological half-life. The variant allele at rs17779352, a synonymous mutation in AHR's basic helix-loop-helix (bHLH) binding domain, was associated with a shorter half-life (adj- $\beta$ =-0.63 years, 95% CI: -1.25, 0.00) while the variant at rs6968865, upstream of AHR in the gene's regulatory region, was associated with a longer half-life (adj- $\beta$ =0.52 years, 95% CI: 0.03, 1.02). Smokers with the variant at rs17779352 had a TCDD half-life that was, on average, 1 year shorter than among non-smokers (pint=0.09). Conclusions: These results suggest that AHR genetics may contribute to TCDD's elimination rate in women, possibly influencing their lifetime sensitivity to TCDD. This is the first study to evaluate the association between genetics and TCDD body burden using longitudinal data.

#### **004.02.16. Persistent Organochlorine Pollutants: Genetic Variations Associated with DDE and PCB153 Blood Levels among Women in France**

Takiy eddine Berrandou

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**Abstract:** Persistent Organochlorine Pollutants including Dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) are ubiquitous in the environment. Many studies have attempted to link DDT or PCB levels in human tissues to the risk of breast and other cancers. However, little attention has been paid to the genetic determinants of DDT and/or PCBs levels. Our aim was to identify genetic variants modifying blood levels of DDE (the major breakdown product of DDT) and PCB153 measured in a sample of women in France. Blood levels of circulating DDE and PCB153 were measured in 1236 healthy women selected as control subjects in an epidemiological study on breast cancer. We genotyped 474 Single Nucleotide Polymorphisms (SNP) in 54 CYP and GST genes involved in the metabolism of DDT and PCBs. Blood concentrations of DDE and PCB153 were explored in relation to each SNP and to the genetic variation in the genes using the Adaptive Rank Truncated Product method. This approach allows investigating the role of a gene seen as a set of SNPs or of a set of genes in DDE and PCB153 levels, and to gain statistical power as compared to a SNP by SNP approach. P-values were adjusted for multiple testing by False Discovery Rate (FDR) method. Blood levels of DDE and PCB153 were significantly associated with several SNPs located in CYP genes. The top-SNPs were rs8192719 (FDR=3x10<sup>-26</sup>) for DDE and rs7255904 (FDR=0.01) for PCB153, both located in CYP2B6. At the gene level, CYP2B6 was associated with levels of DDE (FDR=2x10<sup>-4</sup>) and PCB153 (FDR=0.01). Genetic variation in the whole gene-set including CYPs and GSTs was significantly associated with blood levels of DDE (p=2x10<sup>-4</sup>) and PCB153 (p=2x10<sup>-4</sup>). These findings show that polymorphisms in genes involved in the metabolism are important determinants of organochlorine compound levels measured in humans, and should be taken into account as possible modifiers of the association between PCB and DDT levels and disease risk in epidemiological studies.

#### **O04.02.17. Biomonitoring-Based Antibiotic Body Burden of Adults in Shanghai**

Hexing Wang

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**Abstract:** Background: Monitoring of common used antibiotics in urines has indicated a heavy antibiotic burden in children and pregnant women in East China, but there is lack of data in adults. Objective: To investigate the antibiotic body burden of adults in Shanghai by analyzing common antibiotics in urines. Methods: A large-scale adult cohort was established to explore the risk factors of chronic diseases in Shanghai between 2016 and 2017. Based on this baseline survey, we randomly selected 530 adults aged 21-75 years from two towns located in the suburb in 2017 and 18 common used antibiotics were determined in their spot urines by the isotope dilution-based UPLC-Q/TOF MS. The antibiotics were from five categories (4 fluoroquinolones, 3 phenicols, 3 tetracyclines, 3 macrolides, and 4 sulfonamides) and there were 4 veterinary antibiotics, 4 human antibiotics, and 10 human/veterinary antibiotics. Results: Except for clarithromycin, other 17 antibiotics were detected in urines and the detection frequencies varied greatly by specific antibiotics with a overall detection frequency of 46.3%. Ciprofloxacin, ofloxacin, trimethoprim, and florfenicol were frequently detected in urine with detection frequencies between 8.1% and 14.9%. The detection frequencies of fluoroquinolones, phenicols, tetracyclines, macrolides, and sulfonamides ranged from 1.9% to 28.7% and for veterinary antibiotics, human antibiotics, and human/veterinary antibiotics, those ranged from 3.2% to 39.1%. The maximum unadjusted concentration of 17 antibiotics ranged from 1.9 ng/ml to 5985.8 ng/ml with four antibiotics beyond 1000 ng/ml. The concentration sum of all antibiotics in antibiotic-positive urines varied between 0.02 ng/ml and 5986.4 ng/ml with a mean of 92.2 ng/ml. Conclusion: Adults were extensively exposed to multiple types of antibiotics in Shanghai and carried a heavy antibiotic body burden. More researches are needed to identify the sources and assess the potential health risks.

## **O04.02.18. Relation of Maternal Serum Concentrations of Persistent Organic Pollutants to Vitamin D in Southern California**

Gayle Windham

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**Abstract:** Background/Aim: Low levels of vitamin D in pregnancy are associated with adverse birth and developmental outcomes. Persistent organic pollutants (POPs) are considered endocrine disrupting chemicals and have been suggested to interfere with vitamin D metabolism. Only a few studies of POPs and vitamin D levels have been conducted in humans, but not on polybrominated diphenylethers (PBDEs) or polyfluoroalkyl substances (PFAS). We sought to examine this relation in a population-based sample of pregnant women. Methods: Mother-child pairs with banked biospecimens were sampled as part of a case-control study of children born 2000-2003 in Southern California. 25-Hydroxyvitamin D (OHD), 5 PBDE congeners and 8 PFAS were measured in mid-pregnancy serum from 417 population control mothers. Log-transformed (lipid-adjusted for PBDEs) POPs concentrations were modelled in relation to continuous and categorized OHD (<75nmol/L, or "insufficient", vs. ≥75nmol/L) using linear and logistic regression, adjusting for maternal age, race, education, and parity. Results: Median OHD was 86 nmol/L and 37% of mothers had OHD insufficiency. Increasing 2-(N-ethylperfluorooctane sulfonamido) acetate (Et-PFOSA-AcOH) was inversely associated with OHD, whereas BDE-28 was directly associated with OHD. Higher Et-PFOSA-AcOH was also associated with increased odds of OHD insufficiency (OR=1.3, 95% CI [1.0-1.7]); however higher perfluorononanoate (PFNA), BDE-28, BDE-100 and BDE-153 were associated with decreased odds of OHD insufficiency (OR=0.6, CI [0.4-0.9], OR=0.7, [0.5-0.9], OR= 0.8, [0.6, 0.997] and OR=0.8 [0.6-0.97], respectively). Conclusions: In this first study to examine PFAS and PBDE concentrations in relation to vitamin D levels in pregnancy, associations were found in both directions. These findings highlight the need for additional research to understand these relationships and their potential impact on health outcomes.

## 004.02D. Greenness Effects 3

### 004.02.19. Health Risk Assessment of Community Riverside Regeneration in Barcelona

David Rojas-Rueda

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**Abstract:** Access to natural outdoor environments in cities may promote physical activity and improve human's health and wellbeing. This study aimed to quantify the impacts on the health and health-related economics of an urban riverside regeneration, which consisted on creating the Besòs riverside Park by providing access to the riverbanks and creating a huge green area next to the river. A counting campaign and a survey of riverside Park users describing their physical activity levels, the duration, and frequency of their visits to the regenerated area, were used to estimate their metabolic equivalent of task (MET-min/week). We used a bespoke quantitative risk assessment tool, which related physical activity (in MET-min/week) and health outcomes obtained from existing meta-analyses, to estimate the age and sex-specific health impacts in terms of all-cause mortality, morbidity (including ischemic heart disease; ischemic stroke; type 2 diabetes; cancers of the colon and breast; and dementia) and disability-adjusted life years (DALYs). We conducted a health economic evaluation in terms of the value of statistical life and direct health costs. Almost 6,000 adult users visited the regenerated riverside Park daily and performed different types of physical activities (i.e. walking for leisure or to/from work, cycling, and running). Among these users we estimated an annual reduction of -3.4 (95% CI; -10.8; -0.1) deaths, -6.2 (95% CI; -19.4; -0.5) cases of diseases, and -11 (95% CI; -36.8; -0.5) DALYs. We estimated savings of -11.4 (95% CI; -36.9; -269,642) million Euros on mortality and direct health-care costs. The urban riverside regeneration of the Besòs riverside Park has resulted in substantial quantifiable benefits to the public health in terms of increased physical activity. Similar accessible riverside renewal projects might improve the health of urban populations, mitigating major public health challenges resulting at least partly from physical inactivity.

## **O04.02.20. Associations between Area-Level Greenness and Infant Mortality Rates in Philadelphia, PA**

Leah Schinasi

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**Abstract:** In our rapidly urbanizing world, there is great interest in using greening strategies to promote health. A growing body of epidemiologic literature shows that green space protects against mortality among adults. However, few studies have explored the relationship between green space and infant mortality, defined as any death occurring in children under one year of age. We investigated the relationship between overall greenness and census-tract level rates of infant mortality in Philadelphia, PA, for years 2010-2014. Overall greenness in each census tract was estimated using satellite images of the normalized difference vegetation index (NDVI). Census tract level counts of total annual infant mortality cases and births were downloaded from the Vital Statistics Report of the City of Philadelphia. Aggregate numbers of infant deaths and births within each census tract for all years of the study period were calculated. We used Bayesian spatial areal unit, conditional autoregressive models to estimate associations between greenness and infant mortality. The models included a set of random effects to account for spatial autocorrelation between neighboring census tracts. Infant mortality counts were modeled using a Poisson distribution, and the logarithm of total births in each census tract was specified as the offset term. Models were adjusted for census-tract level percentages Black/non-Hispanic and living below the poverty line. Across 371 census tracts, the mortality rate ranged from 0 to 49.5/1,000 births. In adjusted models, the rate of infant mortality was 22% higher in less green compared to more green tracts. In stratified models, the relationship between greenness and infant mortality was stronger in tracts with higher percentages living below the poverty line. These results contribute to mounting evidence that urban greenness is a health promoting environmental asset.

## **O04.02.21. Greater Residential Tree Cover Is Associated with Reduced Stress-Related Physiological Dysregulation in Residents of Central North Carolina**

Andrey Egorov

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**Abstract:** Background: Urban green spaces have been linked to reduced morbidity and mortality. Alleviation of chronic stress is a hypothesized mechanism of these salutogenic effects. Our previous research showed that greater residential greenness was associated with lower allostatic load suggesting reduced physiologic dysregulation. The objective of this analysis was to assess the effects of different vegetation types on the distribution of allostatic load values. Methods: This cross-sectional study involved 186 adult residents of the Durham-Chapel Hill, NC urban area. High-resolution metrics of tree and grass cover within 500 m of each residence were produced using US EPA EnviroAtlas database. Weighted tree cover measures were produced allowing for an exponential decay of effect with distance from residence. Serum samples were tested for fifteen biomarkers of neuroendocrine, metabolic, and immune functions. Allostatic load was estimated as a standardized distance from the center of a joint multivariate distribution of biomarkers (Mahalanobis distance). Statistical analysis involved two stages: (1) generalized additive regression models of allostatic load on socio-demographic covariates and a thin plate smoothing function of geographic coordinates; and (2) quantile regression of residuals from the 1st stage on a weighted proportion of tree or grass cover. Results: Individuals in the 3rd tertile of tree cover distribution compared to individuals in the 1st tertile had 8% (1%; 15%), 12% (4%; 20%), and 23% (12%; 33%) lower predicted values of the 50th, 75th, and 90th percentiles of the marginal distribution of allostatic load respectively. Grass cover was not a significant predictor of allostatic load. Conclusions: Trees near residence may help to alleviate chronic stress preventing stress-related physiological dysregulation (allostatic load). Health benefits may be stronger in individuals with greater chronic stress. This abstract does not represent EPA policy.

## **O04.02.22. Residential Greenness and Breast Cancer Survival after a Breast Cancer Diagnosis**

Peter James

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**Abstract:** Background: Natural vegetation, or greenness, has been shown to promote physical activity, social engagement, and cognitive restoration, and reduce ambient pollutants. Greenness was also associated with lower rates of cancer mortality among women. Our objective was to determine if greenness was associated with lower rates of breast cancer mortality. Methods: The Nurses' Health Study II is an ongoing US nationwide prospective cohort study. Participants with Stage I-III breast cancer diagnosed from 1989-2013 were followed until June 2014 for total and breast cancer specific death. The Normalized Difference Vegetation Index (NDVI) is a satellite-based measure quantifying vegetation density within a 1-km area. NDVI estimates were linked to residential addresses. We calculated time-varying cumulative average greenness from diagnosis until the end of follow-up. We performed multivariable Cox proportional hazards models to estimate hazard ratios (HR) and 95% confidence intervals (CI) and used restricted cubic splines to explore non-linear associations. We assessed effect modification by clinical factors, physical activity, population density and region. Results: Among 1,890 breast cancer cases, there were 213 breast cancer deaths and 255 deaths from all causes. Cumulative average greenness was not associated with breast cancer specific mortality (HR for a 0.1-unit increase in NDVI=1.03; 95% CI 0.88, 1.21) or all-cause mortality (HR=1.04; 95% CI 0.90, 1.19). We observed no modification by clinical factors, population density, and physical activity. While patterns in the Midwest and West suggested benefits for those residing in the highest and lowest levels of green space, results were inconclusive given the small number of events within region. Discussion: The benefits of residential greenness exposure may not extend to breast cancer specific mortality. Regional differences in green space may point to environmental and behavioral differences that should be further explored.

## **O04.02.23. Residential Greenness and Mortality in a Prospective Cohort of Oldest-Old Women and Men in China**

John Ji

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**Abstract:** Background: Exposure to nature, or greenness, may affect health through several pathways, including health-promoting activities and influencing psychological well-being. How greenness affects old-age health vulnerabilities has not been assessed. Objective: We assessed the relationship between residential greenness and its relationship to mortality in an elderly cohort representative of China. Methods: We used the prospective China Longitudinal Health Longevity Survey (CLHLS) cohort to assess the relationship between greenness and mortality. Our exposure was assessed by satellite derived Normalized Difference Vegetation Index (NDVI) in 250m and 1250m radius around residential addresses between 2000 to 2014 in 3839 women and men. We calculated cumulative, contemporaneous, and change of NDVI values over time. We used all-cause mortality, excluding accidental death, as our outcome measurement. Results: The mean age of our study population at baseline was 92 (sd: 7.57) years. Among 3839 subjects totaling 13253 person-years, we observed 3244 deaths during follow up. We used cox-proportional hazard models, adjusted for age, gender, ethnicity, rural/urban residence, geographical region, education years, occupation before age 60, marital status, smoking status, alcohol consumption, exercise, financial support, and co-residence status. Compared to the lowest quartile of contemporaneous NDVI values, those in the highest quartile had a HR of 0.82 (95% CI: 0.74 - 0.92) for the 250-m radius, and 0.76 (95% CI: 0.69 - 0.85) for the 1250-m radius. No significant effects were not found for cumulative NDVI measurement. Conclusion: In this prospective cohort of older adults, we observed that living in areas with higher levels of greenness was associated with lower levels of mortality. Furthermore, those living in areas of increasing greenness over time also saw a reduction in mortality. Our research has policy implications for eco-civilization and preparing for aging societies in China.

## **004.02.24. The Association between Long-Term Neighborhood Greenness and Lethal Prostate Cancer in a Prospective Cohort Study of Male Health Professionals in the United States**

Hari Iyer

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**Abstract:** Background Emerging literature documents health benefits of natural environments. We studied the association between neighborhood greenness and 26-year incidence of lethal prostate cancer (CaP), effect modification by address type (home or workplace), and mediation by vigorous physical activity. Methods Participants in the Health Professionals Follow-up Study, a nationwide prospective cohort, were followed from 1986 to 2012. We excluded those with history of CaP or missing address. Lethal CaP was defined by metastasis or CaP death. Neighborhood greenness was measured using normalized difference vegetation index (NDVI) with 1km<sup>2</sup> resolution. Participants were assigned NDVI corresponding to their address at start of follow-up, taking averages over four seasonal measures. NDVI was modeled using quintiles. Data were analyzed using sequentially adjusted Cox regression models: 1) age, calendar year, race, family history, smoking, BMI at 21, PSA screening, census median income and home value, walkability index; 2) vigorous and non-vigorous physical activity, current BMI. Results 46,494 participants met eligibility criteria. Men in greener neighborhoods at baseline experienced lower rates of lethal CaP (model 1: Q2 v Q1, aHR: 0.84, 95% CI: 0.67-1.05; Q3 aHR: 0.86, 95% CI: 0.69-1.07; Q4 aHR: 0.77, 95% CI: 0.61-0.97; Q5 aHR: 0.86, 95% CI: 0.69-1.09, ptrend=0.11). Protective associations were strongest among men (39%) reporting work addresses (Q2 v Q1, aHR: 0.73, 95% CI: 0.51-1.02; Q3 aHR: 0.61, 95% CI: 0.42-0.89; Q4 aHR: 0.55, 95% CI: 0.37-0.83; Q5 aHR: 0.65, 95% CI: 0.42-1.00, ptrend=0.0005). Further adjustment for mediators (model 2) did not change effect estimates. Conclusions Our findings suggest a protective association between neighborhood greenness and lethal CaP independent of physical activity, though overall results were not statistically significant. Stronger associations at work suggest benefits may arise from passive rather than active engagement with nature.

## 004.02E. Neurodevelopment in Children

### **004.02.25. Postnatal Exposure to Secondhand Smoke Measured with Urinary Cotinine and Neurodevelopment at 36 Months after Considering Outdoor Fine Particle (PM2.5)**

Myeongjee Lee

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**Abstract:** Background/Objective Neurodevelopment of infants have been associated with exposure to secondhand smoke (SHS) and air pollution (AP), respectively. There has been very few previous studies of combined effect of AP and SHS on early neurodevelopment. We aim to investigate the combined effect of postnatal AP and SHS exposure on neurodevelopment of infants at 36 months of age. Methods This study is a part of the Mothers and Children Environmental Health (MOCEH) study, a Korean multi-center prospective birth cohort study initiated in 2006. We measured infants' urinary cotinine at 24 months and 36 months of age to represent postnatal SHS exposure. PM2.5 (particulate matter <2.5 in diameter) level from conception was modelled using the Community Multiscale Air Quality Modeling. The exposure estimations of PM2.5 of each subject were assigned in district level. Infant's mental developmental index (MDI) and psychomotor developmental index (PDI) were measured using the Bayley Scales of Infant Development at 36 months of age. General linear model was used to assess the relationship between combined exposure of PM2.5 and SHS and neurodevelopment. Results MDI score of 36 months aged infants was marginally associated with log-transformed urinary cotinine level at 24 months [ $\beta = -1.94$ , 95%confidence interval (CI): -3.92, 0.04] after adjusting for log-transformed urinary cotinine level at 36 months and PM2.5 level after birth. The association was statistically significant when the effect of PM2.5 level at early pregnancy was considered,  $\beta = -2.02$  (95%CI: -4.01, -0.03). The effect was pronounced in the metropolitan city,  $\beta = -7.92$  (95%CI: -13.15, -2.70). No association was found in PDI score. Conclusions These findings suggest that infants' postnatal exposure to SHS combined with exposure to PM2.5 may result in delayed neurodevelopment in early childhood. Therefore, we should take care of both indoor and outdoor air pollution with regards to the neurodevelopment of infants.

## **O04.02.26. Prenatal Exposure to Bisphenol A and Childhood Neurodevelopment in Shandong, China**

Yan Zhang

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**Abstract:** Background: Experimental and epidemiological studies suggest that prenatal exposure to Bisphenol A (BPA) may interfere with children neurodevelopment. However, current evidence was inconsistent and relevant study from China is limited. Methods: Based on a cohort in northern China, BPA concentrations were measured among 506 pregnant women and neurodevelopment was assessed using the Gesell Development Schedules for their children at 12 months (n=368) and 24 months (n=296). Linear regression and generalized linear models were used to analyze the association between prenatal BPA exposure and children's developmental quotients (DQs). Results: The median of maternal BPA concentrations were 0.48ug/L or 1.05ug/g creatinine. Prenatal BPA levels were adversely associated with children's DQ scores at 12 months of age, with a 10-fold increase in prenatal BPA levels correlated to 1.43-point decrease in adaptive domain DQs (95%CI: -2.30 to -0.56, p=0.001). When stratified by child gender, prenatal BPA concentrations were adversely associated with the DQs on adaptive domain among boys and the DQs on adaptive domain and social domain among girls. No association was found between prenatal BPA exposure and children's DQs at 24 months of age. Conclusion: Based a Chinese population, we demonstrated potential impacts of prenatal BPA exposure on neurodevelopment for children at 12 months of age, which differ between child age and gender.

## 004.02.27. Sensitive Windows of Manganese Exposure and Frontal Cortex Function in Adolescents

Julia Bauer

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**Abstract:** Introduction: Prior studies have reported Mn-associated decrements in IQ, a composite score computed from subtests. We examined patterns of IQ subtest scores to generate hypotheses about the underlying structural changes in the brain that may be produced by early life Mn exposure among adolescents living near ferromanganese industry. Methods: We analyzed deciduous teeth from 190 Italian children ages 10-14 years. Mn was measured in the tooth matrix to represent prenatal, postnatal (0-1 year) and childhood (~1-6 years) exposure periods. Neuropsychologists administered the Wechsler Intelligence Scale for Children, 3rd edition. Multivariable linear regression and generalized additive models were used to estimate adjusted associations between ln-tooth Mn and scores on seven subtests: Arithmetic, Comprehension, Information, Similarities, Vocabulary, Digits forward and Digits backward. Results: We observed varied patterns of adjusted associations between tooth Mn and subtest performance, depending on the window of exposure. Overall, subtests associated with Mn across exposure windows measure memory, problem solving and attention, suggesting frontal system and hippocampal involvement. We found inverted U-shaped associations between prenatal Mn and Arithmetic, Comprehension, Information and Digits forward ( $p_{\text{gam}}=0.18-0.39$ ). Early postnatal Mn was associated with better performance on Arithmetic ( $\beta=0.27$  (95%CI=-0.63, 1.17)), Information ( $\beta=0.35$  (95%CI=-0.42, 1.13)), and Digits forward ( $\beta=0.51$  (95%CI=0.21, 0.81)). However, childhood Mn was associated with lower Information scores ( $\beta=-0.35$  (95%CI=-1.11, 0.41)) and non-linearly associated with Digits forward ( $p_{\text{gam}}=0.06$ ). In these data, the shape of the Mn-subtest relationship was dependent on exposure timing. Conclusion: Our results suggest that frontal cortex function may be sensitive to Mn exposure. Higher Mn may be toxic in childhood, potentially identifying a window for intervention implementation.

## **004.02.28. The Association between Prenatal Selenium-Related DNA Methylation Modifications in Placenta and Newborn Neurobehavioral Development: An Epigenome-Wide Study of Two U.S. Birth Cohorts**

Fu-Ying Tian

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**Abstract: Background/Aim:** As a micronutrient, selenium (Se) levels in pregnancy have been linked with the neurobehavioral development of the offspring. DNA methylation is a potential mediator of the effect of Se on neurobehavioral development; however, very few studies have investigated the role of DNA methylation in relation to prenatal Se and child neurobehavior. We aimed to investigate the associations between placental Se and epigenome-wide DNA methylation in two U.S. cohorts and to assess the association between Se-related DNA methylation modifications and children's neurobehavioral development. **Methods:** We measured placental Se concentration of 343 newborns enrolled in the New Hampshire Birth Cohort Study and of 141 infants in the Rhode Island Child Health Study. Genome-wide placental DNA methylation was measured by HumanMethylation450 Bead Chip, and the newborn neurobehavioral development was assessed by the NICU Network Neurobehavioral Scales. We meta-analyzed the associations between placental Se concentration and DNA methylation in each cohort, adjusting for confounders ( $P < 1 \times 10^{-5}$ ). We also fit multiple linear regression to assess the associations between DNA methylation and newborn neurobehavioral development. **Results:** We identified 25 Se-related differentially methylated CpG sites. 18 of the 25 CpG sites were positively associated with placental Se concentration. Among the 18 CpG sites, increased DNA methylation of cg19730691 (OR [95% Confidence Interval, CI] = 0.92 [0.86, 1.00],  $P = 0.05$ ) and cg09674502 (OR [95%CI] = 0.89 [0.81 0.99],  $P = 0.03$ ) were also associated with lower risk of high-level hypertonic responses of infants. The nearest genes to the cg19730691 and cg09674502 are TBX15 and GFI1. **Conclusions:** The Se-related increase of TBX15 and GFI1 DNA methylation were associated with beneficial motor development in infants. Future work will assess the relationship of the identified CpG sites methylation levels with childhood motor development.

## **004.02.29. Neonatal Vitamin D Status in Relation to Autism Spectrum Disorder and Developmental Delay in the Charge Case-Control Study**

Rebecca Schmidt

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**Abstract:** Background Vitamin D is essential for proper neurodevelopment and cognitive and behavioral function. We examined newborn vitamin D in relation to later diagnosis of autism spectrum disorder (ASD) or developmental delay (DD). Methods Children aged 24-60 months enrolled in the population-based CHARGE case-control study were clinically confirmed to have ASD (n=373), DD (n=136), or typical development (TD, n=234) at the MIND Institute (Sacramento, CA) using standardized assessments. Total 25-hydroxyvitamin D (25OHD) was measured using sensitive isotope dilution LC/MS/MS in archived dried blood spots collected for the California Department of Public Health's Newborn Screening Program. Associations between 20 nmol/L 25OHD change and ASD and DD were assessed using unconditional multivariate polynomial logistic regression; associations between 25OHD and Mullen Scales of Early Learning (MSEL) and Vineland Adaptive Behavior Scales (VABS) scores were assessed using multivariate linear regression. Effect modification was examined using stratified models and interaction product terms. Results Neonatal 25OHD was associated with significantly reduced ASD only in females (aOR=0.66; 95% CI: 0.48, 0.91,  $p=0.01$ ). 25OHD was significantly associated with reduced DD before (OR=0.84, 95% CI: 0.73, 0.97) but not after adjustment for maternal pre-pregnancy body mass index, prenatal vitamin intake, and education, and child race/ethnicity (aOR=0.91, 95% CI: 0.78, 1.06). Similarly, MSEL and VABS were significantly associated before, but not after adjustment for several factors that could contribute to vitamin D status. Significant interaction by race/ethnicity was observed ( $p=0.02$ ), with an association between 25OHD and DD only in non-Hispanic white children (aOR=0.76; 95% CI: 0.61, 0.95). Conclusions This study provides evidence that newborn vitamin D could be associated with ASD in females and with DD in non-Hispanic white children. Future studies should investigate genetic interactions.

## **O04.02.30. Maternal Thyroid Anomalies and Risk of Autism Spectrum Disorders**

Ran Rotem

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**Abstract:** Background Thyroid hormones play pivotal roles in neurodevelopment. The fetus is dependent on maternal supply of thyroid hormones throughout gestation, suggesting that factors influencing maternal thyroid function may also relate to adverse neurodevelopmental effects in progeny. Impaired thyroid homeostasis has been linked with exposure to several environmental toxicants, yet consequences in the offspring remain unclear. We evaluated the risk of Autism Spectrum Disorders (ASD) in children born to mothers with thyroid anomalies, and the relation between gestational maternal thyroid levels and ASD risk. Methods The study included 436,188 singletons born in 1999-2013 in a large Israeli health fund. Data on ASD diagnoses, maternal thyroid conditions, drug dispensing and lab results were obtained through 2017. Mothers with thyroid conditions were identified through ICD9 codes with subsequent validation through review of drug dispensing data and lab results. ASD cases were identified through ICD9 codes and validated through review of medical records. Analyses were performed using generalized estimating equation (GEE) and general additive logistic regression models using penalized splines. Results Mothers who had ever experienced hypothyroidism were at a higher risk of having a child with ASD compared to women without thyroid conditions (aOR=1.28, 95% C.I.:1.13-1.44). Stratified analysis based on time of first diagnosis indicated elevated risk estimates for diagnoses initially recorded both before and after the delivery date. Analysis of first-trimester TSH levels suggested a linear association with ASD risk at moderately elevated levels. Use of thyroid replacement medications during pregnancy did not mitigate the observed effects. Conclusions The results suggest that factors which influence thyroid metabolism could also play a role in the etiology of ASD. Environmental triggers known to influence thyroid function should be carefully evaluated for their neurodevelopmental effects.

## 004.02F. New Methods, Models and Tools in Chemical Exposure Estimation

### **004.02.31. A New Analysis and Visualization Tool to Identify Chemical Exposure Disparities by Demographic Traits**

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**Abstract:** Variations in chemical exposure by demographic traits have been well studied individually for specific chemical classes but are not systematically studied for a wide range of chemicals to contrast the influence of demographic traits on chemical exposure patterns. This study aims to develop a new analysis and visualization tool that enables us to analyze and compare exposure patterns in the US Population 1999-2014 for a large number of traits and chemicals by using the National Health and Nutrition Examination Survey (NHANES) of 229 chemical biomarker concentrations measured in 74,942 participants. We conducted a series of multiple regression models with the chemical biomarker levels as the outcome variable and the main predictors as age, sex, ethnicity, smoking behaviors, and poverty income ratio while adjusting for urinary flow and study years. We developed a visualization tool known as the Alphabet Soup Plot that displays the regression coefficient of each inherent trait for each chemical biomarker and identified widespread differences in chemical biomarker levels by different populations. For most phthalates, there is little to no difference in chemical biomarker levels by race with the exception of mono-ethyl phthalate (used in cosmetics), which is shown to be on average 53%, 103%, and 74% higher in Mexican, Other Hispanic, and Non-Hispanic Black participants respectively than in Non-Hispanic White participants. PFOS and PFHS are shown to be of higher concentrations in Non-Hispanic White participants compared to Mexican and Other Hispanic participants by over 20% and are also shown to be higher in individuals of high socioeconomic status by over 27%. Development of this visualization tool enables us to comprehensively quantify the influence of several inherent traits on multiple chemical exposure patterns and to identify which combination of chemicals and populations should be prioritized for further toxicological evaluation and targeted health interventions.

## **O04.02.32. Using Sheds-S/D Model to Estimate Soil and Dust Ingestion Rates for Adults**

Heidi Hubbard

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**Abstract:** Soil and dust ingestion is the primary pathway for environmental exposure to some pollutants. As is the case with children, incidental soil and dust ingestion rates for adults are dependent on the amount of time they contact soil, personal hygiene, and the dustiness of the indoor environment. However, there are little data on adult dust and soil ingestion rates. Here we used the Stochastic Human Exposure and Dose Simulation Soil and Dust (SHEDS-S/D) model to estimate distributions of soil and dust ingestion rates for adults across a range of hobbies and activities that would drive their soil and dust contact. Adults in the population were modeled in four groups: baseline/typical adult; moderate soil contact (e.g., a hobbyist gardener); high soil contact representative of occupational exposure (e.g., agricultural workers); and high dust contact approximating an individual who spends appreciable time in a particularly dusty environment, such as a building undergoing renovation. For SHEDS-S/D model runs we developed new soil adherence factors and new distributions of indoor dust loadings representative of renovation scenarios. Also, new model parameters were developed for adults on: The area of hand mouthed; frequency of hand-to-mouth contact; and the hand contact ratio hand contact with dust or soil. Results showed that annual average adult soil ingestion rates could range from 8 to over 100 mg/day. Moreover, high-dust environments could increase dust intake by a factor of 4. Season-specific runs showed considerable differences between the summer and winter soil and dust ingestion rates; summer values being the highest and winter values the lowest. Sensitivity analyses showed the key drivers of predicted exposures to be carpet dust loading; soil adherence; and variables describing hand-to-mouth, soil and dust contact values. These results identify key data limitations for focusing future research activities to obtain robust soil and dust ingestion rates for adults.

### **O04.02.33. Using Geospatial Methods to Quantify the Co-Dispersion of Mercury Sources and Exposures in River Otter (*Lontra Canadensis*) for Risk Prediction**

Kristin Eccles

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Abstract: Mercury is an environmental contaminant of concern due to the established effects of methylated mercury (MeHg) on neurological functioning. Sentinel species such as the river otter (*Lontra canadensis*) are commonly used to monitor environmental mercury concentrations. Fur mercury has proven to be a reliable and cost-effective measure of exposure to MeHg in river otters and is a good proxy for assessing environmental mercury concentrations. A total of 311 geolocated fur samples were obtained from wildlife biomonitoring programs at Environment and Climate Change Canada and from the North American Fur Auction. These samples represent 131 unique locations throughout Canada collected between 2013 and 2016. Total mercury (THg) was measured on a MA-3000. Clustering of high THg was assessed using Getis and Ord's  $G_i^*$ . The association between fur THg and mercury sources was assessed using linear regression modelling alongside spatial regression methods such as geographically weighted regression. A cluster of low fur THg concentrations was observed in Alberta, and clusters of high fur THg concentrations were observed in northeastern Ontario, New Brunswick, and Nova Scotia. There is a statistically significant ( $p < 0.05$ ) negative relationship between fur THg and proximity to dam reservoir water, and pH of soil. There was also a statistically significant interaction between proximity to dam reservoir water and the pH of the soil. Otters that live closer to the reservoir water of dams have higher fur THg concentrations. This effect is enhanced if the soil pH surrounding the reservoir is also low. Using a geographically weighted regression these variables explain up to 35% of the variance. Results from this research are important for assessing the impact of future hydroelectric dam development on aquatic ecosystems. This research also further supports the use of river otter fur as a biomonitoring tool for environmental mercury exposure.

#### **O04.02.34. INLA-SPDE Models to Predict the Spatial Distribution of Beta-Hexachlorocyclohexane Haematic Levels in a Heavily Polluted Area**

Matteo Scortichini

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**Abstract:** Introduction the Sacco River Valley has been characterized over the years by the presence of several industrial plants. In 2006 it was discovered that livestock were contaminated by beta-hexachlorocyclohexane ( $\beta$ -HCH) and two biomonitoring campaigns were performed to assess the human burden. The aim of the study is to estimate the spatial distribution of  $\beta$ -HCH hematic levels in the study area as to use it in future studies on the whole resident population. Data and Methods Between 2010 and 2015 740 subjects were randomly sampled from the resident population and blood samples were collected. Every subject was georeferenced by residence address and considered as a "monitoring site". An Integrated Nested Laplace Approximation (INLA) model combined with Stochastic Partial Differential Equation (SPDE) was run to predict the  $\beta$ -HCH levels. This approach allows Bayesian inference when a spatial process defined over a continuous domain is involved. In the model age, sex, latitude, longitude, altitude and distance from the Sacco river (considered as the main driver of contamination) were also fitted as predictors. Results After excluding subjects spatially isolated, the model was run on 703 observations. A significant relationship was observed between age and the log-transformed  $\beta$ -HCH (posterior mean for 1 year increase: 0.047), higher levels were estimated in women. A negative relationship was found for distance from the river (-0.020 for 100m increase in the distance), while the other predictors had no effect. We validated the model by running a 10-fold Cross-Validation, with a correlation index between observed and predicted equal to 0.77. Conclusions This is the first study using blood sample measures to estimate the spatial distribution of  $\beta$ -HCH. Although strong assumptions were made in order to consider subjects as monitoring sites, this kind of analysis would allow to estimate the effect of  $\beta$ -HCH not only on this sampled population, but also on the cohort of all residents.

## **O04.02.35. Modeling Exposure Reduction for Personal Level Interventions**

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Abstract: Through the APIC-ESTEE (Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology) project, we have developed a model for the reduction of personal exposures to air pollution to assess the health impacts of interventions such as face mask wearing and use of indoor air purifiers. The model accounts for population level time activity patterns and micro-environmental concentrations. A preliminary analysis for Beijing used data on time activity patterns based on Chinese exposure factors; indoor and outdoor fine particulate (PM<sub>2.5</sub>) concentrations came from residential home studies, a study of public indoor environments, and a feasibility personal monitoring study. In-transit concentrations were estimated as 110% of ambient concentrations. Three intervention scenarios were modelled - wearing a highly effective or a poorly effective facemask whenever a person is outdoors or in transit and use of an air purifier in the home environment. The effects of these interventions were modelled assuming 'average' (84 µg/m<sup>3</sup>) and high (396 µg/m<sup>3</sup>) outdoor PM<sub>2.5</sub> concentrations. Data for potential exposure reduction for the face mask scenario came from a study of total inward leakage in a volunteer trial with diesel exhaust exposure. Data for the air purifier scenario came from a literature review. Use of a highly effective mask reduced 24-hr average personal exposure by 27% over the baseline scenario of no intervention, while the air purifier reduced exposure by 29% for the average ambient condition. For the high ambient concentration scenario, the highly effective mask reduced exposure by 26% compared to 25% for the air purifier. With a poorly effective mask, the personal exposure reduction under average and high ambient concentrations was 11%. The model will be further developed in a probabilistic form for modelling population level exposure interventions and health impacts.

## **O04.02.36. Ethical Considerations in Modeling and Tools for Measuring Exposure**

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Abstract: Developing methods and modeling strategies to estimate potential chemical exposure in populations can provide powerful tools for identifying high-risk communities, generating novel hypotheses, and prioritizing mitigation efforts. Although a potentially powerful tool several ethical issues relating to the methods employed should be considered. What is the quality and quantity of the data used in the modeling tools (i.e., how many samples and how were they collected and processed to assure quality)? How are the models validated? How is the location of human participant data shared, either in visualization tools or with other researchers? When location is used in geospatial modeling when should informed consent be obtained. What is the role of the community in determining how their community is represented and how and who in the community is involved in understanding the modelled data? If human samples were used in the development of the models, such as urine or blood biomarkers, what is the responsibility of the researcher to report the findings back to the participants? These large environmental datasets could be enhanced by community collected data or citizen science. What is the role of citizen science in large-scale environmental data collection used for modeling? What is the obligation of the scientist to use these data to promote public health action? These questions will be used as a basis for engagement in discussion about the ethical aspects of exposure assessment.

## 004.02G. PFAS and Other Health Outcomes

### **004.02.37. Perfluoroalkyl Substances (PFASs) and Liver Inflammation and Fibrosis in Children with Nonalcoholic Fatty Liver Disease (NAFLD)**

Ran Jin

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**Abstract:** Background: Perfluoroalkyl substances (PFASs) cause liver toxicity in rodents and might contribute to the increased prevalence of NAFLD. Children appear to have higher body burden of PFASs and a more progressive form of NAFLD; however, no previous studies have examined effects of PFASs on liver histology, the gold standard for NAFLD assessment. Methods: Concentrations of perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonic acid (PFHxS) were quantified in serum of 70 children (7-19 years of age) with biopsy-proven NAFLD, and their associations with liver histological features were examined using multinomial logistic regression models with adjustments for age, sex, ethnicity and BMI Z score. Liver histological features, including grade of steatosis (0-3), lobular inflammation (0-3), portal inflammation (0-2) and fibrosis stage (0-4), were scored according to the NASH Clinical Research Network scoring system. 'Liver inflammation score' was calculated as sum of scores for lobular inflammation and portal inflammation. Results: NAFLD patients were mostly boys (71.4%) and Hispanics (51.4%). The median and interquartile range (IQR) of serum PFOA, PFOS and PFHxS concentrations were 3.42 (1.58), 3.67 (4.48) and 1.53 (3.17) ng/ml, respectively. The odds of having moderate-to-severe inflammation (score >1) compared with no inflammation (score =0) increased with each IQR increase of PFHxS (OR: 3.38, 95% CI: 1.04-10.9). Similarly, the odds of having significant fibrosis (score ≥2) compared to no fibrosis (score =0) increased by 3.95 (95% CI: 1.23-12.7) with each IQR increase of PFHxS. No statistically significant associations of PFOA and PFOS levels with severity of steatosis, inflammation or fibrosis were observed. Conclusions: PFHxS exposure was associated with severity of liver inflammation and fibrosis in children with NAFLD.

#### **O04.02.38. Prenatal Exposure to PFAS and Evaluation of Child Attentional Function at 4-6 Years of Age: The INMA Study, Spain**

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**Abstract:** Background. Few studies have assessed the possible association between prenatal exposure to perfluoroalkyl substances (PFAS) and attentional function. We aimed to study such an association during preschool years. Methods. The study population was 921 mother-child pairs (recruitment period: 2003-08), from the Gipuzkoa, Sabadell, and Valencia-INMA cohorts (Spain). PFAS were analyzed in the first-trimester maternal plasma. Attentional function was assessed using the Conners' Kiddie Continuous Performance Test (K-CPT) at 4-6 years of age. We studied three indicators: omission errors (assesses inattention), commission errors (assesses impulsivity), and hit reaction time standard error (HRT-SE, assesses sustained attention). We conducted multivariate regression analyses between log<sub>2</sub>-transformed PFAS and the outcomes in each cohort and subsequent meta-analysis. We assessed sex effect modification, conducted multi-pollutant analysis, and excluded preterm and small for gestational age newborns. Results. PFHxS, PFOA, PFOS, and PFNA median levels were 0.55, 2.32, 5.91, and 0.63 ng/mL, respectively. We did not find any association between PFAS and child attentional function for the whole population. Although a non-clear differential effect between sexes (*p*-interaction>0.05) was found, higher estimates of the association between commission errors and the four PFAS were shown in girls, reaching statistical significance for PFNA (Beta: 1.3 [95%CI: 0.02, 2.05] associated with a 2-fold increase in PFNA levels). Estimates did not differ markedly in other sensitivity analyses. Conclusions. Results did not suggest an association between maternal PFAS and attention in preschool children. However, more research is needed to analyze this relationship in other populations at the same or older ages, and to assess a possible association in girls. Funding. ISCIII-FEDER (PI12/01890, PI13/1944, PI14/00891, PI17/00663, MS11/0178, MSII16/00051, MS16/00128), and Alicia Koplowitz Foundation 2017.

#### **004.02.39. Perfluoroalkyl Substances (PFAS) Blood Levels and Health Outcomes in Residents Following Contamination of the Community Water Supply in Paulsboro, New Jersey**

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**Abstract:** Background: Perfluoroalkyl substances (PFAS) are chemicals of emerging concern. A PFAS, Perfluorononanoic Acid (PFNA), was detected in the community water supply (CWS) of Paulsboro, NJ at a ten-fold higher level than the NJ groundwater criterion (10 ng/L). In 2014, the CWS was filtered to remove PFAS. Little is known about the health effects of PFNA, concerns include disruption of immune response; disruption of cholesterol homeostasis; and adverse liver, thyroid and/or reproductive system effects. Methods: A class-action lawsuit awarded Paulsboro residents a blood test for 11 PFAS. Consenting participants provided those blood test results and were surveyed about demographic and health information. The geometric means of PFAS serum levels were compared to those of the 2013-2014 NHANES. Linear regression was used to assess associations between PFNA levels and demographics. Logistic regression was used to assess associations between PFAS serum levels and self-reported health outcomes (high cholesterol; circulatory issues, CVD, neurological diagnoses, and pregnancy outcomes). Results: Four PFAS were detected in >25% of 194 participants: perfluorohexane sulfonate (PFHxS; 70.9%), perfluorooctane sulfonate (PFOS; 96.9%), perfluorononanoic acid (PFNA; 97.9%), and, perfluorooctanoic acid (PFOA; 98.5%). PFOA and PFNA serum concentrations were significantly higher among study than NHANES participants (PFNA: 0.91 ng/L, 95 %CI: 0.87, 0.96, vs. 3.50 ng/L 95 %CI: 3.04, 4 .04; PFOA: 2.08 ng/L 95 %CI: 1.91, 2.26 vs. 3.03 ng/L, 95 % CI: 2.70, 3.40). Among the 105 participants with health data, PFNA blood levels were significantly associated with and high cholesterol (odds ratio 1.14, 95% CI 1.02, 1.29). No other significant associations were observed between PFAS and health outcomes. Discussion/Conclusion: PFNA levels in Paulsboro residents exceeded those in the general US population. Further research is warranted to explore associations between PFNA levels and health outcomes.

#### **004.02.40. Breast Cancer Risk and Serum Levels of Per- and Poly-Fluoroalkyl Substances (PFASs): A Case-Control Study Nested in the California Teachers Study**

Peggy Reynolds

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**Abstract:** Background: Per- and poly- fluoroalkyl substances (PFASs) are a large family of synthetic chemicals, some of which are known mammary gland toxicants and endocrine disruptors. Their potential as human breast carcinogens is unclear. Objective: Our objective was to evaluate the risk of breast cancer associated with serum levels of several PFASs in a nested case-control study within the California Teachers Study (CTS). Methods: Participants were 902 women with invasive breast cancer (cases) and 858 with no such diagnosis (controls) who provided 10 mL of blood and were interviewed about specific exposures between October 2011 and August 2015. Serum PFASs were measured using automated online SPE-HPLC-MS/MS methods. Statistical analyses were conducted for six PFASs with detection frequencies > 95%: PFOA (Perfluorooctanoic acid), PFNA (Perfluorononanoic acid), PFUnDA (Perfluoroundecanoic acid), PFHxS (Perfluorohexane sulfonic acid), PFOS (Perfluorooctane sulfonic acid), MeFOSAA (2-(N-Methyl-perfluorooctane sulfonamido) acetic acid). Unconditional logistic regression models were used to calculate the adjusted odds ratio (OR), estimating breast cancer risk associated with each PFAS. Results: With few exceptions, ORs did not statistically differ from one. ORs were less than one and statistically significant for PFOA ( $p=0.043$ ) and PFUnDA ( $p=0.044$ ) and of borderline statistical significance for PFHxS ( $p=0.060$ ), with little evidence for trend. Conclusion: Overall these findings do not provide evidence that serum PFAS levels measured after diagnosis are related to breast cancer risk in this population of middle-aged or older California women. The few inverse associations found may be due to chance or may be artifacts of study design. Future studies should incorporate information about genetic susceptibility, endogenous estrogen levels, and measurements of PFASs prior to diagnosis.

#### **004.02.41. Concentrations of Endocrine Disruptors in Newborn Dried Blood Spots and Child Behavior**

Akhgar Ghassabian

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**Abstract:** Background: Experimental studies suggest that prenatal exposure to endocrine disrupting chemicals interferes with developmental processes in the fetal brain. Yet, evidence is inconclusive. Methods: In a birth cohort (2008-2010, upstate New York), we quantified concentrations of bisphenol A (BPA), perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in stored newborn dried blood spots using liquid chromatography/tandem mass spectrometry. Mothers reported on children's behavior using the Strength and Difficulties Questionnaire at age 7 (650 singletons and 138 twins). Difficulties in behavior (i.e., emotional, conduct, hyperactivity, and peer problems) and prosocial skills were classified at validated cut-offs. We used logistic regression with generalized estimating equations to estimate the odds of having difficulties per exposure category. Models were adjusted for maternal and child characteristics, e.g., ethnicity, smoking, parity, and pre-pregnancy body mass index (and preterm delivery for BPA). Results: 111 children (12.1%) had behavioral difficulties and 60 (6.5%) had problems in prosocial skills. The median (interquartile range) of PFOS, PFOA, and BPA were 1.74 ng/ml (1.33), 1.12 ng/ml (0.96), and 7.93 ng/ml (10.79), respectively. Higher PFOS levels were associated with increased odds of having behavioral difficulties (OR per SD of log PFOS=1.33, 95%CI: 1.05-1.67). We observed associations between PFOS in the highest relative to the lowest quartile and behavioral difficulties (OR for PFOS<sub>1.14-1.74</sub>=1.73, 95%CI:0.87-3.44; PFOS<sub>1.75-2.47</sub>=1.83, 95%CI:0.93-3.57; and PFOS<sub>>2.47</sub>=2.56, 95%CI:1.34-4.91 compared to PFOS<1.41). Higher PFOA levels were linearly associated with problems in prosocial skills (OR=1.36, 95%CI:1.05-1.76). We found no associations with BPA, nor interactions with sex or plurality. Conclusion: Increasing prenatal exposure to PFOS and PFOA, as reflected in neonatal concentrations, may pose risk for child behavioral difficulties.

## **004.02.42. Concentrations of Endocrine Disrupting Chemicals in Newborn Blood Spots and Early Development, Upstate Kids Study**

Erin Bell

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**Abstract:** Novel methods for quantifying chemicals in newborn dried bloodspots (NBS) allows researchers to directly measure exposures in children for examining impact on early development at the population level. We quantified three endocrine disrupting chemicals (EDCs) in NBS and assessed their associations with developmental screening results in the Upstate KIDS population-based birth cohort. The study included 2,049 singletons and 1,030 twins who were followed through age 3. The equivalent of one 16-mm circle was collected from stored NBS and measured for bisphenol A (BPA), perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) using high-performance liquid chromatography/tandem mass spectrometry with limits of detection of 0.30, 0.03 and 0.05 ng/mL, respectively. Parents completed 7 Ages and Stages Questionnaires© between 4 and 36 months of age for each child and results were calculated for failing any of five domains (fine and gross motor, communication, personal-social, problem solving). Using generalized linear mixed modeling techniques with log transformed EDCs, we estimated adjusted odds ratios (aOR) and 95% confidence intervals (CI) per standard deviation increase in log-transformed chemical concentrations. A second random intercept was included to account for clustering between twins from the same family. All models were adjusted for maternal age, education, and infertility treatment. The PFOS and PFOA median concentrations were 1.69 ng/ml (IQR: 1.11, 2.40) and 1.08 ng/ml (IQR: 0.67, 1.60), respectively and 7.89 ng/ml (IQR: 3.38, 14.56 ng/ml) for BPA. Among singletons, failing any domain was not associated with PFOS or PFOA (aOR: 0.89; 0.77-1.05 and aOR: 0.93;0.79-1.09 per SD increase in concentrations, respectively) or with BPA (aOR:1.04; 0.89-1.21). Results did not differ for twins. Using direct measures of EDCs in newborn infants, we observed no association with early development through age three.

## 004.02H. Air Pollution Accountability and Quasi Experimental Studies

### **004.02.43. Triggering of ST-Elevation Myocardial Infarction by Particulate Air Pollution Concentrations in Monroe County, New York: Before, During, and After Multiple Air Quality Interventions and Policies - The Rochester Accountability Study**

Meng Wang

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Abstract: Previously, we reported that increased PM concentrations triggered ST elevation myocardial infarction (STEMI), with the largest rate of MI when pollutant mixtures were high in secondary particles. From 2007-2013, several policies were implemented to improve air quality and reduce pollutant emissions nationally and in New York (NY). In Rochester, NY, concentrations of submicron particles, SO<sub>2</sub>, and PM<sub>2.5</sub> and its main component (SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, elemental and primary organic carbon) were substantially lower AFTER these policies were implemented (2014-2016) than BEFORE (2005-2007) and DURING policy implementation (2008-2013). However, secondary organic carbon (SOC) concentrations increased AFTER implementation. Using 921 STEMIs treated at the University of Rochester Medical Center Cardiac Catheterization Laboratory and case-crossover methods, we examined whether the rate of STEMI associated with increased PM<sub>2.5</sub>, ultrafine particles (UFP, <100nm), accumulation mode particles (100-500nm), black carbon (BC), SO<sub>2</sub>, CO, and O<sub>3</sub>, in the previous 1-72 hours, was modified by period (BEFORE, DURING, AFTER), to evaluate whether pollutant compositional changes affected the relative rate of acute cardiovascular events. Interquartile range increases in UFP concentration in the previous 1 and 3 hours were associated with 12% (95% CI = 3%, 22%) and 11% (95% CI = 2%, 22%) increases, respectively, in the rate of STEMI, with similar patterns for BC, CO, and SO<sub>2</sub>. However, each 3702 particles/cm<sup>3</sup> increase in UFP in the previous hour was associated with a larger increased rate of STEMI in the AFTER period (26%; 95% CI=7%, 48%) than the DURING (5%; 95% CI=-12%, 24%) or BEFORE periods (9%; 95% CI=-4%, 23%). There were similar BC and SO<sub>2</sub> patterns. Given the concomitant changes in PM composition, strong oxidants associated with SOC particles and their ability to induce additional oxidative stress may be particularly important with regard to the triggering of acute cardiovascular events.

#### **O04.02.44. The Effect of Environmental Policies and Hospital Visit Rate by Asthma in Seoul, Korea: Quasi-Experimental Study**

Hyomi Kim

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Abstract: In 2005, "The Master Plan for Atmospheric Environment Management in Capital Area" is established to reduce ambient concentration of air pollutants. Based on the plan, environmental policies to reduce emissions of pollutants are enforced in the capital area in 2007. As a result, it shows good performance compare to the planed emission reduction, especially for traffic related sources. Traffic related air pollutants are known as a one of risk factors for asthma. The objective of this study was to evaluate the effect of environmental policies on hospital visit by asthma in Seoul with consideration of hospital visit rates in a reference population (Daejeon), in Korea. We obtained daily hospital visit count for asthma (ICD10: J45) from National Health Insurance Corporation for the period of 2003 to 2011. PM10, NO2 data were obtained from the National Institute of Environmental Research. We used interrupted time-series regression with Poisson distribution to investigate the effect of policies. Daejeon was selected as similar to population characteristics in the Seoul except for the environmental policies. After the enforcement of policies, the reduction of ambient concentration of air pollutants in Seoul ( $\Delta\text{PM}_{10}=-8.59\mu\text{g}/\text{m}^3, \Delta\text{NO}_2=-0.95\text{ppb}$ ) were greater than Daejeon ( $\Delta\text{PM}_{10}=-1.99\mu\text{g}/\text{m}^3, \Delta\text{NO}_2=1.19\text{ppb}$ ). Percent changes in age-standardized hospital visit rates per 100,000 for the period of 2003 to 2006 were 26.26% in Seoul and 13.27% in Daejeon. However, since the policies has been implemented, percent changes were 3.73% in Seoul and 14.39% in Daejeon. Even after adjusting for hospital visit rate in Daejeon, increasing trend of hospital visit by asthma ( $\beta$  of time trend= $6.676\text{e}-5$ ,  $p<.01$ ) was significantly reduced by implementation of the policies ( $\beta$  of time\*policies= $-1.081\text{e}-4$ ,  $p<.001$ ). This study results showed the evidence that the environmental policies introduced in 2007 has a positive impact on both air quality and hospital visit by asthma in Seoul, Korea.

**O04.02.45. Does the Association between Cardiovascular Hospital Admissions and Fine Particle Concentrations Change Before, During, and After Implementation of Multiple Environmental Policies? The New York State Accountability Study**

Wangjian Zhang

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**Abstract:** Previous studies reported triggering of acute cardiovascular (CV) events by short-term increases in ambient PM<sub>2.5</sub> concentrations. From 2007-2013, policies to improve air quality implemented nationally and across New York (NY), and economic influences, resulted in reduced concentrations of PM<sub>2.5</sub> and other pollutants, but not O<sub>3</sub>, at 6 urban NY monitoring stations. We estimated the rate of CV hospital admissions associated with increased ambient PM<sub>2.5</sub> concentrations in the previous 1-7 days, and evaluated whether they were different BEFORE (2005-2007), DURING (2008-2013), and AFTER policy implementation (2014-2016). Using all hospital admissions with a primary diagnosis of 9 CV disease subtypes, for NY residents living within 15 miles of PM<sub>2.5</sub> monitoring sites in Buffalo, Rochester, Albany, Queens, Bronx, and Manhattan from 2005-2016 (N=1,922,918), the annual CV disease admission rate decreased from BEFORE (15.6/1000 people [‰]) to DURING (13.6‰) to AFTER (11.8‰) implementation. Using a case-crossover design and conditional logistic regression, interquartile range (IQR) increases in PM<sub>2.5</sub> in the previous 0 to 6 days were associated with 0.6%-1.2% increases in the rate of CV admissions (2005-2016). There were similar patterns for cardiac arrhythmia, ischemic stroke, congestive heart failure, ischemic heart disease (IHD), and myocardial infarction (MI). However, the excess rate of IHD admissions associated with each IQR increase in PM<sub>2.5</sub> in the previous 2 days was larger in the AFTER period (2.8%) than in the DURING (0.6%) or BEFORE periods (0.8%), with similar patterns in the previous 1-5 days. Both total CVD and MI, but not other disease groups, followed the same pattern. While pollutant concentrations and CV admission rates decreased AFTER policy implementation, the rates of ischemic heart disease and MI associated with the IQR increases in PM<sub>2.5</sub> increased. Compositional PM changes AFTER implementation may make the same PM<sub>2.5</sub> mass more likely to trigger CV events.

#### **O04.02.46. Air Quality Management Policy and Reduced Mortality Rates in Seoul Metropolitan Area: A Quasi-Experimental Study**

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**Abstract:** Background: The air quality management policy was introduced in Seoul and Incheon metropolitan cities in the Republic of Korea, from 2005 to 2014. Despite particulate matter concentrations decreasing after policy implementation, the consequent health benefits have not been evaluated. Objectives: We evaluated the effects of the air quality management policy on mortality rates in Seoul and Incheon. Methods: Using interrupted time series analysis with a generalized Poisson regression model, we compared daily average mortality rates before (baseline, 2004-2005) and after (2006-2007, 2008-2009, 2010-2011, 2012-2013) the policy implementation. To account for the long term mortality trends, we weighted daily mortality rate of Seoul and Incheon with daily mortality rate of Daejeon (another metropolitan city with no air quality management policy implemented). Results: Decline in the particulate matter concentration was greater in Seoul and Incheon than in Daejeon. After adjusting for potential confounders, there were 8% decrease in cardiovascular disease mortality rates and 10% decrease in cerebrovascular disease mortality rates in Seoul in 2012-2013 compared to the baseline period. In Incheon, an 8% reduction in cerebrovascular disease mortality rates in 2012-2013 was reported. There was no change in mortality rates due to external causes or other causes of deaths excluding cardiovascular and pulmonary disease after policy implementation. Conclusions: Our study suggests that the air quality management policy was effective in reducing mortality rates in Seoul and Incheon.

#### **O04.02.47. A Quantitative Analysis of Health Risk Perception, Exposure Levels, and WTP/WTA of PM2.5 during the 2014 Nanjing Youth Olympic Games**

Lei Huang

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Abstract: Local governments in China regularly implement authoritative short-term emission control measures to improve air quality during important sporting events. As a condition for hosting the 2014 Youth Olympic Games (YOG), the local government of Nanjing agreed to temporarily and substantially improve air quality in Nanjing for the YOG. Regression analysis, Spearman correlation analysis, chi-square test, and the Contingent Valuation method were used to explore the effects of robust, short-term air pollution control measures on 1) health risk perception, 2) daily exposure to PM2.5, 3) health risk acceptance levels, and 4) willingness to pay/accept (WTP/WTA) for eliminating health risk level. Post-implementation, the respondents' health risk perception levels presented the following changes: during the YOG, the respondents perceived the lowest effects of haze pollution while after the YOG, they perceived the highest effects. The changes in health risk acceptance levels showed the same tendency, demonstrating that people were more sensitive to PM2.5 exposure and held higher standards for air quality after the government implemented the emission control measures. Meanwhile, after the YOG, the respondents asked for the most economic compensation and their WTP for risk reduction also reached the highest level. This study reveals the need to 1) raise public awareness about the health risks of air pollution, 2) protect those populations most exposed to high levels of PM2.5, and 3) take more effective long-term measures to meet local residents' demands for improved air quality.

#### 004.02.48. Impact of Improved Air Quality and Genetics on Aging Lungs

Tamara Schikowski

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**Abstract:** Introduction: The beneficial effect of a reduction of outdoor air pollution on lung function in the elderly remains unclear, and scarce data exist regarding the modifying effect of genetics. We examined associations between decline in air pollutants (nitrogen oxides [NO<sub>2</sub>, NO<sub>x</sub>], particulate matter [PM<sub>2.5</sub>, PM<sub>10</sub>] exposure) and lung function measures and their interaction with lung function related risk alleles in elderly German women. Methods: Data were analyzed from the SALIA study (Study on the influence of Air pollution on Lung function, Inflammation and Aging; N=601). Spirometry (FEV<sub>1</sub>, FVC) was conducted at baseline (1985-1994; all women 55 years of age), first follow-up (2007-2010) and second follow-up (2012-2013). Air pollution concentrations at home addresses were determined for each time of investigation using land-use regression models and extrapolation procedures. GLI (Global Lung Initiative) age and height standardized z-scores were calculated. Weighted genetic risk scores (GRS) were determined from lung function related risk alleles and used to investigate their interaction with improved air quality. Adjusted linear mixed models were fitted. Results: FEV<sub>1</sub> and FVC were below predicted values at baseline (mean z-scores < 0) but z-scores increased on follow-up. Air pollution levels fell during the study period (e.g. NO<sub>2</sub> from a median of 33.4 to 19.7 µg/m<sup>3</sup>). Reduction of air pollution was associated with an increase of z-scores for FEV<sub>1</sub> and FEV<sub>1</sub>/FVC. For a decrease of 10 µg/m<sup>3</sup> in NO<sub>2</sub>, the z-score for FEV<sub>1</sub> increased by 0.14 (95%CI: [0.01; 0.26]). However, with an increasing number of lung function related risk alleles, the benefit from improved air quality decreased (interaction between improved air quality (NO<sub>2</sub>) and GRS: p=0.029). Conclusions: Reduction of air pollution is associated with a relative improvement of lung function, still on-going in subjects >75 years. However, the beneficial effects of improved air quality also depend on the genetic make-up.

## 004.02I. Social and Environmental Determinants and Health 1

### 004.02.49. Effects of Night-Time Screen-Based Media Device Use on Adolescents' Sleep and Health-Related Quality of Life

Mireille Toledano

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**Abstract:** Background/Aim: Sleep deprivation among adolescents has reached epidemic levels. In this study we investigated the associations between screen-based media device (SBMD) use and sleep and health-related quality of life (HRQoL). Methods: We analysed baseline data from a large cohort of 6,616 adolescents from 39 schools in and around London, United Kingdom, participating in the SCAMP study. Exposure was self-reported SBMD use (including mobile phone, tablet, eBook reader, laptop, television etc.) within one hour before sleep and whether use occurred in the dark or in a room with light on. Outcomes included variables generated from self-reported weekday and weekend bed, sleep and wake times; sleep quality using dimensions from the Swiss Health Survey; and HRQoL estimated using the KIDSCREEN-10 questionnaire. Results: Over two-thirds of adolescents reported using at least one SBMD within the hour before sleep and about a third of adolescents reported using their mobile phone in darkness. Night-time use of mobile phones and televisions was associated with higher odds of late wake time on weekdays (OR = 1.60, 95% CI [1.05, 2.44] and OR = 1.71, 95% CI [1.15, 2.55], respectively). Use of mobile phones, televisions or at least one SBMD was associated with all adverse weekend sleep outcomes. Whereas there was a 31% increase in the odds of insufficient sleep duration for those who used mobile phones in a room with light on, mobile phone use in the dark was associated with a 147% increased odds of insufficient sleep duration compared to no night-time mobile phone use. Likewise, adolescents who used mobile phones in darkness reported poorer HRQoL compared to those who did not use mobile phones. Conclusion: SBMD use within one hour before sleep was associated with adverse sleep outcomes and HRQoL among adolescents. Although adverse effects of night-time use of mobile phones and televisions on sleep outcomes were observed, the effects were stronger when use occurred in darkness.

#### **004.02.50. Correlates of Stress and Depression in Early Pregnancy in a Low-Income Minority Population**

Claudia Toledo-Corral

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Abstract: Prevalence estimates for depression during pregnancy vary widely with the highest rates in women of lower socioeconomic status and racial/ethnic minorities. Similarly, prenatal stress is also common and can adversely impact both maternal quality of life and fetal development. The aim of this study was to determine socio-demographic and environmental correlates of psychosocial stress and depression in 171 participants of the Maternal And Developmental Risks from Environmental and Social Stressors (MADRES) pregnancy cohort of lower income, predominantly Hispanic women in Los Angeles. The Perceived Stress Scale was used to assess psychosocial stress with a score of 40 indicating the highest level of perceived stress. The Center for Epidemiologic Studies Depression Scale was used to assess depression, with a cut-off score of 16 indicating probable depression. Mutually adjusted linear regression models were employed to evaluate statistically significant predictors of stress and depression. Hispanic ethnicity and years lived in the US were significantly associated with both stress and depression, with recent Hispanic immigrants experiencing the least amount of stress, and immigrants having lived in the US more than 20 years or having been born in the US having less stress compared to non-Hispanic individuals. Despite experiencing the least perceived stress, recent Hispanic immigrants were at most increased risk of being depressed. Being employed, working more than 40 hours a week, having a history of smoking or exposure to second hand smoke, and lack of sleep were all associated with increased perceived stress and depression in early pregnancy. Calenviroscreen 3.0 score, an index of pollutant burden and vulnerability, was not associated with stress or depression. Risk factors for perceived stress and depression in early pregnancy are multifactorial. Teasing out the relative contributions of race, acculturation, and the environment remains a challenge.

#### **004.02.51. The Impact of Socio-Environmental Drivers and Japanese Encephalitis in Shaanxi, China, a Bayesian Spatial Analysis**

Xin Qi

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**Abstract:** Background: With the progress of global climate change and more extreme weather events, areas with lower mosquito borne disease incidence also meet with resurgence of disease. This study examined the association of meteorological and socio-demographical factors with Japanese encephalitis JE (2006-2014) in Shaanxi, China. Methods: JE data at the county level in Shaanxi were supplied by Shaanxi Center for Disease Control and Prevention. Population and socioeconomic data were provided by China Population Census in 2010 and statistical yearly book. Meteorological data were acquired from China Meteorological Administration. A Bayesian conditional autoregressive model was used to examine the association of meteorological and socioeconomic factors on JE. Results: A total of 1,197 JE cases were included in this study. The north of Shaanxi had lowest JE incidence while the south had the highest in most of the study years. Urbanization rate was inversely associated with JE incidence in the whole study period. Meteorological variables were more significantly associated with JE incidence between 2012 and 2014 than earlier years. The north had higher incidence from August to October, 2013 than the middle and south, which may be associated with the excessive precipitation in the north in July, 2013 with 1-3 months lag effect. The spatial residual variations indicated that the whole study area had more stable risk (0.80-1.19 across all the counties) between 2012 and 2014 than earlier years. Conclusion: Extreme weather outweighed other variables in association with spatial pattern of JE incidence. Public health interventions need to be implemented to reduce JE incidence, especially in rural areas and after extreme weather, e.g., rainfall.

## **O04.02.52. Exploring Socio-Environmental Determinants of Pediatric Asthma Disparities in South Carolina**

Matthew Bozigar

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**Abstract:** Treating childhood asthma symptoms through an emergency department (ED) visit is a major burden for both patients and healthcare systems. One opportunity that could improve understanding of risk and ultimately lead to improved public health strategies to reduce ED visits is a better understanding of socio-environmental determinants of disease. The objective of this research is to explore the spatial distribution of pediatric asthma ED visits across South Carolina in order to better understand geographic patterns of socio-environmental risks and disparities, and to support hypothesis generation for future epidemiologic study. To achieve, we map overall ED visit rates, the white/non-white ED visit rate ratio, and socio-environmental factors including median family income and point pollution sources by ZIP code tabulation area (ZCTA) in South Carolina for the period 2005-2015. Results show that elevated ED visit rates exist in rural areas, that low income areas generally coincide with high rate areas, and that there are relatively large statewide disparities between non-white and white residents. In summary, our results reveal striking disparities in the burden of asthma across South Carolina warranting further study.

**004.02.53. Assessing Associations between School Facility Condition, Neighborhood Environment, and Respiratory Health in Public Schools: An Application of Ultrahigh Dimensional Variable Selection Method on Big Data**

Yi Lu

Yi Lu<sup>1</sup>, Wangjian Zhang<sup>1</sup>, Ziqiang Lin<sup>2</sup>, Shao Lin<sup>1</sup>

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**Abstract:** Background: While poor school facility conditions were associated with impaired academic performance in large-scale studies, less research has assessed its health impact among students. Furthermore, strong correlations between variables made it difficult to assess a wide range of environmental factors in one model. In this study, we aim to assess the impact of school and home environmental factors on student's respiratory health in a multi-pollutant model by applying an innovative variable selection method. Method: A case-control study was conducted using statewide hospital records from patients aged 4 to 18 during 2010-2013 in upstate New York. Emergency department (ED) visits due to respiratory diseases were defined as cases, while visits due to gastrointestinal diseases, injury, and appendicitis were used as controls. Each patient was assigned to a school based on the information on patient's age, home address, and school zones. A set of 128 variables indicating school facility conditions and school or home neighborhood environmental hazards were included in the variable selection process. Iterative sure independence screening was applied to construct the final multi-pollutant regression model. Result: Eighteen environmental factors were chosen for the final model, including 11 indicators of school facility conditions and 7 indicators of traffic/industrial emission around the school/home. The strongest associations were found between respiratory ED visit and conditions of tile floor, foundation type, noise from air-conditioning or traffic, PM2.5 level in home neighborhood, active leak in classroom, and heating fuel system (increased risks ranged from 9% to 17%). Conclusion: Application of advanced variable selection method allows construction of multi-pollutant models with wide range of environmental factors. Specific school facility conditions potentially play a crucial role in student's respiratory health even after controlling for neighborhood environment.

## **O04.02.54. Preventing Poorer Health and Shorter Lives**

Adetoun Mustapha

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Abstract: In its 1948 constitution, the World Health Organization (WHO) defined human health in a broader sense as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Epidemiological evidence has shown that a range of factors such as income, education, social status, social support networks, gender, race, genetics, physical environment, individual behaviours, access to and use of health services, influences health outcomes. An approach that addresses both individual-level and population-level determinants of health is therefore important for disease prevention and health promotion. Results of studies presented in this session reveal disparities in the burden of various health outcomes in different social and environmental settings in similar populations and how the use of technology, such as screen-based media devices, is affecting health. What are the ethical bases to address these disparities at both local and global levels? With rapid urbanization, will increased use of screen-based media devices add to the mental health burden globally? What are the responsibilities of technology companies and stakeholders in addressing the impact of technology-use on well-being and social determinants of health? What are the dilemmas and barriers to creating a society in which everyone has a chance to live a long and healthy life? How can public health practitioners enable policy and actions to address these dilemmas and barriers? Ethical perspectives on the interaction between material disadvantage, its social consequences and other contextual aspects of individual lives that determine health and longevity will be discussed. Ways to facilitate multidimensional approaches to health improvement that involves multiple institutions making simultaneous progress on a variety of fronts to address inequalities within and between countries will be explored.

## S04.02A. Innovation in Community-Based Assessment of Residential Wood Smoke Exposure, Health and Solutions

### **S04.02.01. Using Sensors to Distinguish Indoor and Outdoor Source Mechanisms and the Role of Interventions on Particulate Matter Exposure in Smoke-Impacted Homes**

Ian Longley

*Ian Longley<sup>1</sup>, Fay Johnston<sup>2</sup>, Fabienne Reisen<sup>3</sup>, Grant Williamson<sup>2</sup>, Sharon Campbell<sup>2</sup>, Gustavo Olivares<sup>1</sup>, Amanda J. Wheeler<sup>2</sup>*

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Abstract: Indoor and outdoor PM<sub>2.5</sub> continuous monitoring was conducted in eight Hobart, Tasmania homes over a four-week period each to evaluate interventions to reduce the impact of ambient woodsmoke emissions on indoor air quality. The homes were between 2.3 and 15 km from a regulatory ambient PM<sub>2.5</sub> monitoring station. Week one provided baseline information, week 2 intervention was all doors and windows closed, week 3 air conditioning was placed on recirculation and week 4 was a portable HEPA air cleaner. Studies were conducted in two waves: wave one in July/August and wave 2 in August/September. Preliminary data indicate that outdoor PM<sub>2.5</sub> varied substantially between homes and the regulatory site. Indoor/outdoor PM<sub>2.5</sub> ratios for each week ranged from 0.09 to 10.3 (median 0.60). The air cleaner intervention led to the lowest indoor concentrations and I/O ratios in only 2 of the 8 study homes. Inspection of the continuous data indicates that lower concentrations during week 4 in these two homes appeared to be more strongly related to a (presumably coincidental) reduction in the frequency or intensity of indoor emission events, rather than any increase in particle removal. Furthermore outdoor concentrations were strongly reduced during wave 2 compared to wave 1 reducing infiltration and the demand for air cleaning. This presentation will consider alternative reasons for the apparent poor performance of the air cleaning interventions.

## **S04.02.02. Systematic Identification and Prioritization of Communities Impacted by Residential Woodsmoke in British Columbia, Canada**

Sarah Henderson

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**Abstract:** Background: Residential woodsmoke is an under-regulated source of fine particulate matter (PM<sub>2.5</sub>), often surpassing mobile and industrial emissions in rural communities in North America and elsewhere. In the province of British Columbia (BC), Canada, many municipalities are hesitant to adopt stricter regulations for residential wood burning without empirical evidence that smoke is affecting local air quality. The objective of this study was to develop a retrospective algorithm that uses 1-hour PM<sub>2.5</sub> concentrations and daily temperature data to identify smoky days in order to prioritize communities by smoke impacts. Methods: Levoglucosan measurements from one of the smokiest communities were used to establish the most informative values for three algorithmic parameters: The daily standard deviation of 1-hour PM<sub>2.5</sub> measurements; the daily mean temperature; and the daytime-to-nighttime ratio of PM<sub>2.5</sub> concentrations. Alternate parameterizations were tested in 45 sensitivity analyses, and 23 smaller communities (populations < 80,000) were ranked by the number of smoky days identified within a 2-year period. Results: Using the most informative parameter values on the most recent two years of data for each community, the number of smoky days ranged from 5 to 277 out of 730. Heat maps visualizing seasonal and diurnal variation in PM<sub>2.5</sub> concentrations showed clear differences between the higher- and lower-ranked communities. Some communities were sensitive to one or more of the parameters, but the overall rankings were consistent across the 45 sensitivity analyses. Conclusions: This information will allow stakeholder agencies to work with local governments on implementing appropriate intervention strategies for the most smoke-impacted communities. It was also used to identify communities for more detailed assessment using mobile monitoring.

### **S04.02.03. Mobile Monitoring Capability for Citizen Science Approaches to Smoke Exposure Mapping**

Michael Brauer

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- 3. British Columbia Ministry of Environment, Surrey, BC, Canada.*

**Abstract:** Background: Residential woodsmoke is the dominant source of ambient air pollution in many smaller communities throughout the heating season, which raises concerns about individual and public health. Given the localized nature of this source and the spatial variability in ambient concentrations, more spatially resolved data can help communities to adequately characterize woodsmoke impacts and to implement interventions at the local scale. We made mobile monitoring equipment and online mapping tools available to citizen action groups to collect and visualize their own residential woodsmoke data. Methods: First, we conducted fixed and mobile monitoring in three woodsmoke-impacted communities in British Columbia (BC), Canada to establish the general relationship between levoglucosan within fine particulate matter (PM<sub>2.5</sub>) and Delta-C (880 - 370nm) measurements from a dual wavelength aethalometer. Second, we used this relationship to build an online PM<sub>2.5</sub> mapping tool using the Shiny package for R. Finally, we loaned the aethalometer and its integrated global positioning system (GPS) to citizen scientists in other woodsmoke-impacted communities to assess whether they could feasibly collect and visualize their own data with the assistance of a comprehensive user guide. Results: The relationship between daily levoglucosan PM<sub>2.5</sub> and Delta-C varied across the first three communities, but the slope of the pooled data was 1:1 with an R<sup>2</sup> value of 0.90. Citizen groups were able to collect mobile monitoring data. Following multiple modifications to simplify for lay users, the online Shiny application was successful in providing citizen groups with useful woodsmoke maps. Conclusions: Citizen groups can effectively collect and visualize mobile woodsmoke monitoring data if given adequate support from academic and government partners, especially in the early part of the study period.

#### **S04.02.04. Using Distributed Air Sampling to Distinguish Spatial Contributions of Woodsmoke from Other Particulate Sources in a Medium-Sized City**

Jane Clougherty

*Jane E. Clougherty<sup>1</sup>, Ian Longley<sup>2</sup>, Brett Tunno<sup>3</sup>, Gustavo Olivares<sup>2</sup>, Elizabeth Somervell<sup>2</sup>, Sam Edwards<sup>2</sup>, Guy Coulson<sup>2</sup>*

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Abstract: During winter nights, woodsmoke from home heating may be a substantial source of air pollution in smaller cities and towns. In New Zealand towns with relatively little background air pollution, and substantial reliance on woodburning, we have the unique opportunity to examine spatial variance in woodburning-related pollution, and to disentangle its contribution from that of other sources (i.e., diesel). Few studies to date have been able to isolate spatial patterns in exposures during daytime and nighttime, nor to do so using woodsmoke-specific tracers (e.g., levoglucosan), to separate its contribution from that of other sources (e.g., diesel). We captured seven-day integrated samples of fine particulate matter (PM<sub>2.5</sub>), and elemental and organic tracers of woodsmoke and diesel emissions, during daytime and nighttime hours, across one city, over three weeks in early winter. At a subset of sites, we also sampled during hypothesized "peak" evening woodburning hours, to differentiate emissions during active residential woodburning, vs. overnight smoldering. Concentrations of PM<sub>2.5</sub> were, on average, twice as high during nighttime than daytime. Much greater differences were observed, however, in woodsmoke-related tracers (e.g., levoglucosan, potassium) and indicators of treated- or painted-wood burning (e.g., arsenic, lead). Only nitrogen dioxide (NO<sub>2</sub>), calcium, iron, and manganese (common tracers of vehicular emissions) were higher during daytime. Levoglucosan and most PAHs were higher during "active" woodburning, vs. overnight smoldering. Our time-stratified spatial sampling approach detected substantial variability across the study area, and established a strong contribution of woodsmoke to nighttime PM<sub>2.5</sub>. Daytime vs. nighttime differences were greater than differences observed across sites. Traffic, especially diesel, contributed substantially to daytime NO<sub>2</sub> and localized gradients in non-woodsmoke-related constituents.

#### **S04.02.05. Informing Interventions through Use of a Dense Monitoring Network for Rural Woodsmoke Impacted Communities**

Curtis Noonan

*Curtis Noonan<sup>1</sup>, Ian Longley<sup>2</sup>, Brett Taylor<sup>1</sup>, Gustavo Olivares<sup>2</sup>, Tony Ward<sup>1</sup>*

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**Abstract:** Introduction. Rangiora is a rural town in South Island, New Zealand where the use of wood for home heating is prevalent. The West Silver Valley is a historic mining area along the Coeur d'Alene River in northern Idaho, U.S. Due to cold temperature inversions and the predominant use of wood fuels for domestic heating, both communities (and others like them) often exceed health-based standards for particulate matter (PM10 in New Zealand and PM2.5 in the US). Using low-cost PM monitors, we provided policymakers, community members and students across both communities with tools to visualize temporal and spatial variance in ambient woodsmoke. Methods. We deployed 13 low-cost solar powered monitors across Rangiora in 2017 and 12 across the West Silver Valley in 2018, capturing PM2.5 at one-minute intervals over a period of seven and four weeks respectively. Following a quality control procedure, data were ingested into a visualization system previously used by NIWA for presenting weather forecasts and climate summaries for New Zealand. In addition to engaging with residents and state air quality agency personnel, we worked with school administrators to introduce opportunities for students to utilize these dense network air monitoring tools within the context of their science-based curricula. Results. The low-cost monitors exhibited a high degree of stability with nearly 100% data recovery. The data was used to create maps of air quality that described previously unknown spatio-temporal variation in air quality. Animations of the data effectively communicated the highly dynamic nature of air quality and exposure, informing community and regulatory uncertainty over the validity and representativeness of fixed regulatory monitoring sites. Conclusion. A PM sampling network, when combined with visualization tools, reveals new information at a sub-community level that can be used to illustrate fine-grained exposure assessment, stimulate engagement and inform decision making.

## **S04.02.06. Global Evidence of Adverse Health Effects Associated with Residential Wood-Burning**

Jennifer Peel

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*1. Colorado State University, Fort Collins, CO, United States.*

Abstract: Evidence supporting an association between short-term and long-term exposure to several air pollutants, including fine particulate matter, ozone, nitrogen dioxide, and carbon monoxide matter, and multiple health effects is robust. However, evidence regarding exposure to air pollutants emitted from specific sources is more limited. Residential wood-burning emits various components of air pollution and is an important source of ambient, household, and indoor air pollution in many locations throughout the world. In many lower- and middle-income countries, wood, and more broadly biomass, is used by a large proportion of the population for cooking and heating needs and contributes to both household and ambient air pollution. In high-income countries, residential wood-burning is primarily for heating purposes and varies substantially by region and by economic drivers; however, even in high-income countries residential wood-burning can be an important source for both indoor and ambient air pollution. Globally, there have been efforts to reduce exposures resulting from residential wood-burning through the use of improved technology, alternative fuels, regulations, and other approaches, with varying degrees of success. Here, we will review evidence of adverse health effects associated with residential wood-burning from various fields, including ambient air pollution, household air pollution, indoor air pollution, and controlled human exposure studies; we will draw from related evidence, such as wildfire smoke. Synthesizing evidence from across these fields allows for a broader picture of the current evidence, including areas of inconsistent evidence and research needs.

## POSTER SESSIONS

Sunday, August 26 & Monday, August 27: Student Poster Competition

P01. Weather, Climate and Disasters 1

**P01.0020. The Research on National Heat Vulnerability Assessment of China**

ZongHao Du

*ZongHao Du<sup>1</sup>, Mike Z. He<sup>2</sup>, Jie Ban<sup>1</sup>, Qing Wang<sup>1</sup>, Tiantian Li<sup>1</sup>*

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**Abstract:** Background: At present, many countries and regions have conducted heat vulnerability assessment studies to effectively identify vulnerable areas and populations. In China, heat vulnerability assessments have been conducted in some areas, but there is a lack of coverage across many parts of the country. The impacts of heat vulnerability are still unknown for most areas in China. Objectives: We aim to establish a preliminary heat vulnerability index system in China. Based on the establishment of a nationwide county-scale heat vulnerability index, we assessed the spatial distribution of heat vulnerability in China. Methods: We used principal component analysis to reduce the dimension of heat vulnerability indicators. The heat vulnerability index of each county was calculated by a summation of the principal component scores of the corresponding districts and counties. In order to better intuitively understand the distribution of China's heat vulnerability index, we displayed the results of the index on a spatial map. Results: The average value of the heat vulnerability index is 13.84, with a median of 14, and a standard deviation of 1.77. The high vulnerability areas, defined with a heat vulnerability index value of 16-22, include a total of 394 counties/districts. Low vulnerability areas, defined with a heat vulnerability index value of 5-13, include a total of 1061 counties/districts. The spatial pattern map of the heat vulnerability index indicates that there are many areas with low heat vulnerability in the southeastern coastal areas and central regions, and there are many areas with high heat vulnerability in the northeast and western regions. Conclusion: Geographic, urbanization, economic, and health factors are the primary influencing factors of China's heat vulnerability. Low-income groups, low-education groups, ethnic minorities, and the elderly are particularly vulnerable to the effects of heat in China.

## **P01.0040. Using Ambient Temperature and Internet Search Query to Predict Seasonal Influenza Outbreaks**

Yuzhou Zhang

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**Abstract:** The discovery of the dynamics of influenza outbreaks remains a great challenge. The research aims to better predict seasonal influenza outbreaks using climate and big data in Brisbane and Gold Coast, Australia. Weekly influenza notifications, climate data (ie., temperature and rainfall) and big data (ie., internet search query (ISQ)) between January, 2011 and December, 2016 were collected from Queensland Health, Bureau of meteorology, Australia and Google Trends, respectively. A time-series cross correlation function (CCF) was used to compute the correlations between independent variables and influenza over a range of time lags. Increasing duration index ( $\alpha$ ) and increasing intensity index ( $\beta$ ) were used to discover the characteristics of influenza outbreaks. Time series seasonal autoregressive integrated moving average (SARIMA) and regression tree model with climate and ISQ were developed to predict influenza epidemics. The CCF showed that temperature at lag of 1-10 week in both two study settings was inversely associated with influenza, whereas ISQ at lag of 1-7 week was positively associated with the influenza. The largest  $\beta$  value was found in 2015. The inclusion of ISQ and temperature improved the predictive performance of SARIMA model (Brisbane:  $\beta_{ISQ} = 2.42$ ,  $\beta_{temperate} = -25.12$ , increased agreement: 8%; Gold Coast:  $\beta_{ISQ} = 0.38$ ,  $\beta_{temperate} = -7.73$ , increased agreement: 6%;  $p < 0.05$ ). Regression tree model showed that when internet search query  $\geq 65$  and weekly mean maximum temperature  $< 21$ o C, the relative risk (RR) of influenza was 1.6 and 2.9 respectively in Brisbane, whereas internet search query  $\geq 66$  and weekly mean maximum temperature  $< 23$  o C, the RR of influenza was 2.8 and 1.1 separately in Gold Coast. Our results suggested big data in conjunction with temperature can be used to predict influenza outbreaks, which can be considered as a pre-requisite for constructing early warning systems using these data.

## **P01.0050. Assessing the Impact of Cold and Heat Waves on Physical Activity in a Sub-Tropical Urban Population**

Janice Ho

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**Abstract:** Background: Extreme temperatures are increasing due to climate change, however research of their impacts on health behaviour are rare. While cold winter temperatures have been identified as a barrier to physical activity, an increase of extremely hot temperatures due to climate change may also potentially affect frequency of physical activity. This study aims to estimate the change of self-reported frequency of outdoor physical activity (PA) during cold and heat waves in a sub-tropical urban population and identify its predictors. Methods: A prospective population-based cohort telephone survey study was conducted in an Asian sub-tropical city, a week after a 2016 coldwave and followed-up 1.5 years after, a week after a 2017 heatwave. Measures on self-reported changes in outdoor PA in heat and cold waves, sociodemographic variables, health status, warning awareness, temperature-related attitudes and knowledge, and protective behaviours were collected. We conducted multivariable logistic regression analyses to assess predictors of change in outdoor PA over the two extreme temperature events. Results: Temperature and other meteorological variables were significantly different during the cold and heat waves from that prior. The response rate at follow-up was 42.8% (435/1017). Overall, more participants (53.3%) reported a decrease in PA in either or both the heat and cold waves, than reported an increase (10.3%), while 36.3% of participants maintained consistent PA in both the cold and heat waves. Decreased PA was associated with females, worsened health status in winter, awareness of temperature, and certain protective behaviours, while increased PA was associated with students, those under 45, higher income, and better health status in summer. Conclusions: Our findings suggest a greater decrease of outdoor PA during cold and heat waves, and identify gender, age, income, health status, temperature-related awareness, and protective behaviours to be associated.

## **P01.0060. Seasonal Variation in Microclimates and the Role of Regional Weather and Environmental Factors**

Rachel Sippy

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Abstract: Microclimates are an important component of our ecosystem, and can impact human health through heat-related injuries or by affecting disease vectors. Research on microclimates can be difficult; our understanding of the temporal and environmental variation of microclimates is limited. Microclimate data (temperature and relative humidity) were collected over a twelve-month period in a small community in Ecuador, and summarized for over each 24-hour collection period. Using generalized linear models with generalized estimating equations, we assessed the variability of microclimate variables across time and environmental variables, including urbanicity, elevation and vegetation coverage. With local weather station and remotely-sensed climate data, we assessed the relationship between regional weather and microclimates. Two-hundred and eighty-seven log-days of data were collected; the absolute maximum temperature was in July, and the absolute minimum occurred in August. Relative humidity of 100% occurred frequently during the sampling period; the absolute minimum occurred in March. Some microclimate variables were more temporally stable than others (mean, median, and minimum temperature and maximum relative humidity); urban sites had higher temperature variability ( $p=0.0169$ ) and rural sites had higher mean relative humidity ( $p=0.0137$ ), compared to suburban areas. Microclimate temperature variables were associated with remotely-sensed surface temperature ( $p=0.047$ ). Microclimate minimum ( $p=0.0001$ ) and mean ( $p=0.045$ ) temperature were associated with climate station temperature minimum and mean measures, respectively. Relative humidity mean ( $p<0.0001$ ), median ( $p<0.0001$ ), minimum ( $p=0.038$ ), and maximum ( $p=0.0018$ ) were associated with the number of days with precipitation at the climate station. These data demonstrate the need for climate and health researchers to reconsider the meaning and impact of climate variables across spatial scales.

## **P01.0070. Are Per Capita Carbon Emissions Predictable across Countries?**

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**Abstract:** Background China, and many developing countries in Asia followed similar economic growth patterns, which is well explained by the flying geese (FG) model. The phrase FG paradigm was coined originally by Kaname Akamatsu in 1930s and presented to world academia after World War II. It intended to explain the catching-up process of industrialization in late comer economies. Japan, NIEs and China followed the path and had similar economic growth development trajectories. Our "flying S" hypothesis states that if a country locates in a same FG region and the energy matrix is relatively constant, the per capita CO<sub>2</sub> emission curves will mirror to the leading geese in the same FG group. Method Historical CO<sub>2</sub> emission data was obtained from literature review. By sector CO<sub>2</sub> emission of Taiwan and China were obtained from national reports and calculated from bottom-up method. Sigmoid shaped non-linear mixed effect model was further applied to examine the ex post data with 1000 simulated predictions to construct 95% empirical bands from these fits. By multiplying by estimated population, we predicted total emissions of 6 selected countries in the same FG group. Results Per capita emission of CO<sub>2</sub> from the same FG group does mirror to each other, especially among second and third industrial sectors. We estimated an annual 18648.72 Million tons (Mt) of CO<sub>2</sub> emission (95%CI=9770.40-23618.88) and 9030.48 MtCO<sub>2</sub> (95%CI=2887.92-15677.28) in China and India, respectively, in 2030. Conclusion the study bridges a well-known FG paradigm in macroeconomics to a Climate change study and proposes "flying S" hypothesis to predict and explain GHG emissions of the same FG countries in Asia. By exploiting the empirical data to the theory, we provided an alternative framework to predict CO<sub>2</sub> emission of selected countries in 2030 and beyond.

## **P01.0080. Air Conditioning and Heat-Related Illness in Detroit, Michigan, USA: A Community-Based Participatory Epidemiologic Analysis**

Jacqueline Cardoza

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**Abstract:** Intro: Heatwaves are increasing with climate change. Heat-associated health events are borne disproportionately by populations without air conditioning (AC) access--often minority and low-income groups. Detroit, Michigan has well-documented health disparities, including heatwave-associated mortality and hospitalizations. "Heatwaves, Housing, and Health: Increasing Climate Resiliency in Detroit" (HHH), a community-based participatory research (CBPR) collaboration of 5 community-based organizations with a university, investigated the hypothesis that odds of reported heat related illness (HRI) would be greater among respondents with central AC or window unit AC versus no AC and among those with poorer self-rated health. We also piloted a method to increase community partner engagement in the analysis phase of the research. Methods: From 2016-2017, 103 geocoded Detroit residents were surveyed regarding attitudes and behaviors related to heatwaves and HRI occurrence in the past 5 years. Academic partners selected the initial confounders and, after instruction on the use of directed acyclic graphs (DAGs), the collaboration proposed alternate DAGs and confounders. Using logistic regression, HRI was regressed on AC type or health status, and the co-selected confounders, including housing and neighborhood characteristics, utility cost concerns, and age. Alternate models suggested by the DAG were examined. Results: The odds of HRI among those with window AC were 2.86, (95% confidence interval (CI)= 0.69, 11.89) and with no AC 1.39 (95%CI = 0.41, 4.67) compared to those with central AC. The odds of HRI among people with fair/poor health vs. good/excellent health were 2.91 (95% CI=1.25, 6.82). The CBPR co-analysis showed potential confounding by the housing and neighborhood characteristics. Conclusions: In Detroit, HRI may be associated with health status but not AC use. CBPR co-analysis can enhance epidemiologic analyses of community-specific social and health vulnerabilities.

## **P01.0090. Impact of Extreme Heat on End-Stage Renal Disease Patients in the Northeast US Using Selected Clinical Outcomes**

Richard Remigio

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**Abstract:** Many studies on extreme heat and health have shown associations with morbidity and mortality within the general population around the world. However, there is a paucity of data regarding how extreme heat event may impact highly vulnerable populations such as individuals living with end-stage renal disease (ESRD) patients. We investigated the associations between exposure to extreme heat events and clinical parameters in urban ESRD patients undergoing hemodialysis (HD) in three northeastern cities. We used physical and clinical measures collected during HD visits between 2001 to 2012 in three cities: Boston, MA; New York City, NY, and Philadelphia, PA. We extracted meteorological data collected at the nearest meteorological stations from National Oceanic and Atmospheric Agency (NOAA). We identified extreme heat events using same-day (lag0) and one-day lag (lag1) 95th percentile threshold of the distribution of the daily maximum temperature or heat index values for each location. We analyzed the association between exposure to extreme heat events inter-dialytic weight gain (IDWG), predialysis systolic and diastolic blood pressure (pre-SBP, pre-DBP), and mortality and hospitalization using linear mixed effect regression adjusting for seasonality, long-term trends, and day of the week. We used time stratified case-crossover study design for the analysis of hospitalization and mortality data. Exposure to extreme heat event (both lag0 and lag1) was associated with significant decreases in mean IDWG, pre-SBP, and pre-DBP in all three cities. We observed increased mortality among patients residing in Boston, but not in New York or Philadelphia. Findings regarding Hospitalization were not statistically significant. Outdoor extreme heat can affect clinical outcomes among hemodialysis patients. These findings could inform heat management guidelines and treatments for ESRD patients in the context of a changing climate.

**P01.0100. Single-Day Inclement Weather Events is an Adherence Barrier for Treatment among Hemodialysis Patients in Urban Northeastern Cities**

Richard Remigio

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Abstract: Accessing essential health care services is a challenge during inclement weather disturbances that disproportionately impacts medically fragile populations such as end-stage renal disease (ESRD) patients who receive outpatient dialysis. Epidemiologic evidence regarding this relationship is needed to inform adaptation strategies. The overall goal of this study is to investigate the association between inclement weather conditions such as precipitation, snowfall, snow depth, and wind on missed hemodialysis appointments in selected United States (US) northeastern cities: Boston, MA (BOS); New York City, NY (NYC), and Philadelphia, PA (PHL) from 2010 to 2012. We extracted total daily total precipitation, total snowfall, total snow depth, fastest 2-minute wind speed (WSF2), and fastest 5-second wind speed (WSF5) from national weather databases. The relationship between the occurrence of inclement weather events and missed appointments was investigated using marginal logistic regression to determine population-level effects for each location. Inclement snowfall days exhibited consistent increased odds for missed appointments in BOS (Odds Ratios (OR) 4.63 and 95% confidence interval (CI) 2.30-9.31), NYC (OR=1.66; CI: 1.08-2.55), and PHL (OR=1.70; CI: 1.30-2.22). Inclement rainfall days also exhibited a significant impact on HD patients in PHL (OR 1.81; CI: 1.37-2.40); and during inclement snow depth days in NYC and PHL. BOS and PHL demonstrated significant associations during sustained windy days (WSF2). Our results showed that inclement weather conditions have impact on missed appointments among hemodialysis patients. There is need to maintain uninterrupted critical health care and access to medically fragile communities in local climate resilience strategies. As such, weather forecasting has utility for predicting rates of location-specific missed appointments. Coordination between dialysis centers and health providers can enhance medical care preparedness and delivery.

## **P01.0110. Ambient Temperature and Mortality in Australia: An Evaluation of Risk and Attributable Burden for Different Temperature Exposures**

Jian Cheng

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**Abstract:** Background: Non-optimum temperatures, including heat, cold and big temperature variability, can affect human health, but the relative contribution of these exposures to mortality and the pattern of population's adaptation have not been fully understood yet. Objectives: This study examined the death risk after exposure to different non-optimum temperatures (i.e., heat, cold, and short-term temperature variability), and associated death burden. Population's adaptation, measured as the pattern of death risk over time, was also analysed. Methods: We modelled associations of mortality with heat during warm season, with cold during cold season, and with temperature variability all year round, separately, in five largest Australian cities (Sydney, Melbourne, Brisbane, Adelaide and Perth), from 2000-2009. Optimum temperatures, above or below which death risk would continuously rise, was used as the reference to calculate the relative risk (RR) of heat and cold, and to estimate the attributable fraction. We used the estimates of temperature variability that have been reported in our previous research. Results: We observed similar death risk for heat (RR: 1.020, 95% confidence interval (CI): 1.013-1.027) and cold (RR: 1.013, 95% CI: 1.005-1.020), and the lowest death risk for temperature variability (RR: 1.005, 95% CI: 1.003-1.007). There was no clear and consistent increasing or decreasing pattern in death risk associated with different exposures in most cities. Among the estimated total attributable deaths, most were due to cold (53.6%), followed by contributions from temperature variability (33.1%) and heat (13.3%). Conclusion: On average, cold and heat in Australia had comparable size of death risk, which was greater than risk of temperature variability, and most temperature-induced deaths were from cold and temperature variability.

## **P01.0120. Comparative Assessment of Heat-and-Cold-Related Emergency Department Visits in China and Australia: Population Vulnerability and Attributable Burden**

Jian Cheng

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**Abstract:** Background: Non-optimal ambient temperatures have detrimental impacts on mortality worldwide, but little is known about the difference in population vulnerability to non-optimal temperatures and temperature-related morbidity burden between developing and developed countries. Objectives: We estimated and compared the associations of emergency department visits (EDV) with non-optimal temperatures in terms of risk trigger temperature, the average slope of exposure-risk function and attributable risk in 12 cities from China and Australia. Methods: We modelled the associations of EDV with heat during warm season and with cold during cold season, separately, using generalized additive model after controlling for temporal variations. Population vulnerability within a given region was quantified with multiple risk trigger points including minimum risk temperature, increasing risk temperature and excessive risk temperature, and average coefficient of exposure-risk function. Fraction of EDV attributable to heat and cold was also calculated. Results: We found large between- and within-country contrasts in the identified multiple risk trigger temperatures, with higher heat and cold trigger points observed in Australia than in China. Heat was associated with a relative risk (RR) of 1.009 [95% confidence interval (CI):1.007, 1.011] in China, which accounted for 5.9% (95% CI: 3.2%, 8.5%) of EDV. Higher RR of heat was observed in Australia (1.014, 95% CI: 1.010, 1.018), responsible for 4.0% (95% CI: 2.3%, 5.7%) of EDV. For cold effects, the RR was similar between two countries, but the attributable fraction was higher in China (9.6%, 95% CI: 6.1%, 12.9%) than in Australia (1.5%, 95% CI: 0.0%, 2.9%). Conclusions: Exposure to heat and cold had adverse but divergent impacts on EDV in China and Australia. Further mitigation policy efforts incorporating region-specific population vulnerability to temperature impacts are necessary in both countries.

**P01.0130. A Time Series Analysis of Associations between Climate Change and Heat Related Illnesses and Development of Heat Health Warning System in Thailand**

Chuleekorn Tanathitikorn

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Abstract: A heat health warning system (HHWS) is not set up in Thailand and there is an increasing number of heat - related illnesses (HRI) yearly. As a result of this, the aims of this study is to implementing a suitable threshold level for HHWS in Thailand, which could be different from NOAA guideline. Method: This study were divided into 3 phases with mixed method approach. In phase 1, Daily HRI of hospital admissions from the ICD10 database with diagnosis T67 (Effects of heat and light) were collected between January 2010 to December 2014. Daily temperature and humidity from the same period were obtained. Heat index (HI) was calculated according to the Steadman equation. Time series and Poisson regression analysis were used to find out the relationship between HRI and heat index controlling for day of the week and holiday indicator, for lag times of 1- 7 days. Relative risk (RR) and 95% confidence interval were calculated in each increment of inter-quartile range (IQR) change of HI by each region of Thailand. Next, e-Delphi technique was applied to elicit the opinions of 16 experts involved in climate research. Lastly, to verify the phase 2 findings, a focus group discussion with key stakeholders and policy makers was planned. Results: RR increase 33% (95%CI: 29%-38%) when HI increase per IQR (7.3) in Thailand. The relative risks at 75th percentile of HI at lag 0 of Southern, Northern, Central and Northeast regions were 5.56, 21.76, 79.59, and 39.75, respectively. Threshold level for HHWS are divided to 3 levels, which are pre-alert, higher alert and highest alert level. Based on expert's opinions, the pre- alert level is the level of HI below 75th percentile, the higher level is the level of HI from 75th percentile to 90th percentile. Lastly, the highest level is start from 90th percentile of HI. Conclusion: The level of HI has a positive association with HRI and the suitable warning threshold level for HHWS of Thailand are different from United State of America.

## **P01.0150. The Role of Temperature and Temperature Variability in Risk of Stroke**

Sebastian Rowland

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**Abstract:** Background: While it has been well established that extreme temperatures are a risk factor for adverse health, including acute cardiovascular events, previous epidemiologic research has failed to flexibly assess diurnal variation in temperature and, thus, comprehensively understand the impact of temperature dynamics. We investigated the association between multiple metrics of temperature exposure and stroke hospitalizations. Methods: We used stroke hospitalization and residential address data from the Statewide Planning and Research Cooperative System (SPARCS) dataset of the New York Department of Health for 2012 and 2014 over New York State. We linked events to hourly temperature and relative humidity from the North American Land Data Assimilation System (NLDAS). We employed a time-stratified case-crossover design, also matched on hour of event, to examine whether different temperature metrics over the 48-hr prior to event are related to risk of stroke. The metrics included max and mean, standard deviation (SD), max absolute first difference, and SD of first differences. Results: We observed 48,497 events over the study period. Higher mean and max temperature were associated with 4.9% (95%CI: 0.7, 9.0%) and 9.0% (95%CI: 3.8, 15.0%) increase in the rate of stroke admissions per 10oC, respectively. Different variability metrics showed different strengths of association. We found 0.7% (95%CI: -0.1, 1.8%) increase in risk per 1oC increase in SD, 1.7% (95%CI: 1.3, 2.2%) per 0.1oC increase in SD of first differences, and 1.9% (95%CI: 1.3, 2.5%) per 0.5oC increase in max absolute first differences. Conclusion: Our findings suggest that temperature changes may increase risk of stroke. The observed associations depended on the metric used, implicating different biological or behavioral mechanisms. More research is needed to understand the relevant biological mechanisms and appropriate interventions.

**P01.0160. Effect Modification of Heat Wave Characteristics and Influence on Variability in Mortality in Northwestern India**

Amruta Nori-Sarma

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**Abstract:** While the relationship between heat waves and health has been studied, questions remain regarding health effects of heat waves that occur in climates with high baseline temperatures, especially under a changing climate. Additionally, questions remain regarding causal inference, and whether prior results for high effects early in season apply universally. Few studies have assessed the relationship between heat waves and health outcomes in India and no study assessed how heat wave characteristics, including intensity, duration and seasonality, influence the health burden associated with heat. Data from city registrars and local meteorological departments were collected (period 2000-2012, varying by community) for 4 communities in Northwestern India. Propensity Score Matching (PSM) was used to obtain attributable mortality and relative risk of mortality in regards to a variety of heat wave definitions (n=13) incorporating heat waves' duration, intensity as well as timing in season. Relative risk of heat waves (risk of mortality comparing a heat wave day to matched a non-heat wave day) ranged from 1.28 [95% CI: 1.11, 1.46] in Churu to 1.03 [95% CI: 0.87, 1.23] in Idar and Himmatnagar. Some heat wave definitions resulted in a high relative risk of deleterious health effects, however so few days match those criteria that the absolute health burden was small. Heat waves that occurred later in season were much more deleterious to health, contributing to more attributable deaths than early season heat waves. Heat waves have harmful health effects even in places with high baseline temperatures, and the effect of heat waves varied by heat wave definition as well as by health endpoint. Unlike previous studies, heat waves occurring later in season were more harmful across the study area. These findings are critical from a policy perspective, as a tool for policy makers to determine the most important local criteria for declaring a heat wave.

## **P01.0170. Putting the Economic Cart before the Healthy Horse: Barriers and Opportunities for Health Co-Benefits in Climate Change Mitigation Policies**

Annabelle Workman

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Abstract: Numerous health benefits can result from the implementation of climate change mitigation policies. At a time when ambitious action is urgently needed, accounting for benefits of climate change action in policy development is imperative. The domestic and near-term benefits to human health that arise from implementing climate mitigation policies can provide a strong justification for developing increasingly ambitious climate change policies. The policy development process is complex, especially for a multi-scale, multi-sectoral policy issue such as climate change. To gain a better understanding of the process, and how health fits, we interviewed Australian and European Commission (EC) climate change policy-makers. We developed case studies for Australia and the European Union (EU) using theoretical insights from the political economy literature in conjunction with data from the interviews and analysis of key Australian Government and EC documents. We found that the complexities of the policy-making process, in conjunction with politico-economic and institutional realities, can create barriers for the integration of health co-benefits into climate change mitigation policies[1]. In better understanding the policy development processes for these Parties to the United Nations Framework Convention on Climate Change (UNFCCC), we identify specific strategies to enhance the role of health co-benefits in the development of Australian and EU climate change mitigation policies, which may be relevant more broadly, at the sub-national level and for other Parties to the UNFCCC. Insights gained from our research can be used by environmental health researchers to support the translation of research into policy-making. [1] Workman, A., G. Blashki, D. Karoly, and J. Wiseman. 2016. "The Role of Health Co-Benefits in the Development of Australian Climate Change Mitigation Policies." *International Journal of Environmental Research and Public Health* 13 (9). doi:10.3390/ijerph13090927.

## **P01.0180. Proposition of Lags and Variables for a Cold-Health Watch and Warning System in the Province of Quebec**

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Abstract: Extreme cold and hot weather events have serious impacts on human life and health, and have been shown to increase daily mortality. The heat waves of recent years led many countries to establish their heat-health watch and warning systems (HHWWS) to prevent the effects of extreme heat. In spite of known impacts, there have not been many studies that concern warning systems for cold. In temperate regions, winter mortality is generally higher than the rest of the year. This is especially true for the province of Quebec, where the winter is long and usually very cold. Thus, it is of interest to establish a cold-health watch and warning system. However, cold studies are a bit different than heat studies. On the one hand, the delay between exposure to high ambient temperatures and mortality is short, whereas the effects for extremely cold temperatures is usually much longer (for example, 21 days in studies of associations between meteorological variables and cold-health outcomes). A watch and warning system concerns rather a high excess mortality caused directly by meteorological variables such as the daily minimum and maximum temperatures. However, since the direct effects of these meteorological variables decrease with time, it will be impossible to take a very long lag for a watch and warning system. On the other hand, a HHWWS usually takes into account temperature and humidity, but in order to establish a cold-health watch and warning system, we have to consider different meteorological variables. Therefore, the objectives of this study are to: 1) determine the lag for the cold-health watch and warning system (based on an approach from HHWWS), and 2) propose relevant meteorological variables for this system. To evaluate the performances of this system, it is applied to the province of Quebec. It is a good start to establish a general and elaborate cold-health watch and warning system in this province.

## **P01.0190. Impact of Anomalous Temperature on Injury Mortality by Age and Sex in the USA**

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**Abstract:** Background Extreme temperatures which deviate from long-term averages will be more frequent as the global climate changes, and could have adverse health consequences. Much previous work has focussed on how mortality from natural causes is affected by daily or multi-day hot/cold episodes, and not on weather patterns that reflect inter-annual variations, as expected under global climate change, nor on injuries. Methods We formulated a Bayesian spatiotemporal model to estimate how deviations from long-term averages of mean monthly temperature as well as number of monthly extremes affect injury mortality in the contiguous USA. Our model incorporates how mortality varies by age, sex, state of residence, and month and year. Importantly, it associates monthly injury death rate to inter-annual variation of temperature from the average 30-year climate. We calculated injury death rates for each age group, sex, state and year from national vital statistics over a 34-year period (1980 to 2013) and monthly population-weighted temperature statistics from the ERA-Interim project, which combines predictions of a physical model with ground-based and satellite measurements. Results Risk of dying from unintentional injuries increased in anomalously-warm June/July months in males, up to 1.8% (95% CI 1.2 - 2.5) per degree Celsius in July. Males  $\leq 55$  years were also at increased risk throughout spring and summer months, by up to 2.0% (1.0 - 3.2) in May. Only females 5-24 years were at increased risk in anomalously-warm months, and only in summer months. Intentional injuries showed no consistent relationship with anomalous temperatures. We will also show findings on transport accidents, accidental falls, accidental drowning, self-harm and assault. Conclusion More frequent or extreme anomalously-warm months will increase mortality for unintentional injuries in spring and summer months for males. There will be no change in mortality from intentional injuries.

## **P01.0210. Pollen Counts in Four Canadian Cities: Geographical Variation between 2008 and 2012**

Cecilia Sierra-Heredia

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Abstract: Pollen grains from anemophilous plants represent an important class of aeroallergens in ambient air. High concentrations of aeroallergens, including tree and grass pollen are associated with increased asthma-related emergency department visits and hospitalizations across Canada. The geographical distribution of species of plants is dependent on multiple factors, including precipitation, soil composition and moisture and average high and low temperatures. Five "floristic zones" that support the growth of different aeroallergen-producing plants have been defined across Canada. Here we examine the differences among four Canadian cities (Vancouver, Edmonton, Winnipeg and Toronto) situated in four of the Canadian floristic zones. We describe pollen counts with respect to: start and end dates of the pollen seasons; season length; and annual pollen counts between 2008 and 2012. These cities and years were chosen to cover the antenatal and perinatal windows of sensitization for the participants in the Canadian Healthy Infant Longitudinal Development (CHILD) birth cohort. Pollen season was defined considering the dates when the 5% and 95% of the annual total was recorded for each pollen. The following table presents the 5-year average for pollen count and season duration for trees and grasses. With these data and estimates of traffic-related-air-pollution exposure we will present the combined effects in the development of early-life asthma. Trees Grasses City Average pollen (grains/m<sup>3</sup>) Average season duration (days)

Average pollen	Average season duration	Participants
Vancouver/42926.2/92.6/1497.8/74.6/992		
Edmonton/7368.4/71.2/1522.3/54.4/774		
Winnipeg/16904.1/50.8/1564.3/70.6/738		
Toronto/16915.5/71.2/991.8/107/770		

The geographical differences may suggest the particular needs of atopy prone and sensitized individuals in each city, and the potential need to account for local contexts when designing public health initiatives related to aeroallergen information and to green space.

## **P01.0220. Spatio-Temporal Analysis of Dengue Cases in Queensland, Australia, 2010-2015**

Rokeya Akter

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Abstract: Dengue, an acute infectious disease, is a public health concern in northern Queensland, Australia characterised by annual outbreaks. This study explored spatio-temporal characteristics of dengue cases in Queensland, to identify high-risk areas at fine spatial scale and thereby help in planning resource allocation for dengue control measures. Notifications of dengue cases for Queensland at statistical local area (SLA) level were obtained from Queensland Health for the period 2010 to 2015. Spatio-temporal analysis was performed, including plotting of seasonal distribution and decomposition of cases, using linear regression models and creating choropleth maps of cumulative incidence. The space-time scan statistic (SaT Scan) and a geographical information system were used to identify and visualise the space-time clusters of dengue cases. A total of 1773 dengue cases with 632 (35.65%) autochthonous cases and 1141 (64.35%) overseas cases were reported in Queensland during the study period. Both autochthonous and overseas cases occurred more frequently in autumn and showed a geographically expanding trend over the study period. The most likely cluster of autochthonous cases (RR=54.52,  $p<0.001$ ) contained 50 SLAs in the north-east region of the state around Cairns occurred during 2013-2015. A cluster of overseas cases (RR of 60.81,  $p<0.001$ ) occurred in Herston (Brisbane) during 2012 to 2013. These results could be useful in directing future investigations on risk factors and effective interventions in these high-risk areas.

**P01.0230. Kidney Injury within Arid/Semi-Arid Climates: A View Nationally and Within the San Luis Valley, Colorado**

Amber Vaughn

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**Abstract:** Background: Chronic kidney disease (CKD) is a non-communicable disease considered a global health problem. CKD of unknown or non-traditional causes (CKDu) subtype is localized to geographical areas with causes poorly understood. CKDu prevalence is common among rural, agricultural, working-aged men in dry climates. We examine prevalence of CKD with exposure of arid climates nationally, and kidney injury with dehydration and agricultural occupations within the San Luis Valley (SLV), Colorado. Methods: State level data (N=51) of prevalence of CKD (2014), stratified by age, were used for simple linear regression between CKD and arid states. In the second tier of analysis utilizing the SLV cohort (N=1890) and excluding people with diabetes. Logistic regression was used comparing kidney injury with dehydration and agricultural occupations adjusting for age, sex, ethnicity, blood pressure, and smoking. Results: Arid states (n=16) have a 0.07 increased prevalence of CKD compared to non-arid states for populations 20-64 years in 2014 (95%CI:0.03-0.10, p-value:<0.01). Within the SLV (n=1142), people with kidney injury were 1.78 times more likely to drink low amounts of water compared to people drinking high amounts of water after adjusting for risk factors (95%CI:1.27-251, p-value:<0.01). Outdoor labor jobs were looked at as a factor for kidney injury. Conclusions: Kidney injury is prevalent within the SLV, and exposure to dehydration is a risk factor. Additionally, state aridity could help locate areas of increased risk for CKDu. This further understanding helps identify sensitive populations and provides support for local interventions.

**P01.0240. Development and Selection of an Appropriate Model of City Level Dengue Fever Incidence in China Using Autocorrelation, Population, Weather, Climate, Vegetation, and Land Use Predictors**

Megan Clegg

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**Abstract:** Background/Aim: Dengue Fever is a vector borne disease that predominantly effects countries in tropical latitudes. In recent years the incidence rate in many countries has been increasing identifying the need for accurate predictive models. We develop and assess several models of dengue fever incidence at the 'City' administrative level in China using autocorrelation, population, weather, climate, vegetation, and land use variables. Methods: The dataset was first cleaned and processed to weekly time scales. Initial descriptive analysis included incidence rates, correlation, spatial and temporal autocorrelation analysis. Several models were then built and assessed for their suitability. These included the Zero-Inflated Negative Binomial Model, the Distributed Lag Non-Linear Model, the Generalised Additive Model with random effects, and the Random Forest Model. Results: Models were successfully fitted for all four methods. While many studies identified through a literature review used some form of Negative Binomial or Poisson model, this method was not suitable for this data because of both the variation in cases across different City categories, and the nonlinear nature of the relationship between cases and weather variables. The Distributed Lag Nonlinear Model also did not yield satisfactory results, with the model substantially overpredicting almost all case counts. The Generalised Additive Model fit the observed data very well, however, it was reliant on the random effects specified for 'City' to produce such a good fit and could not be used for predictions as a result. Finally, a Random Forest Model was investigated. This model was successful in fitting the observed cases without using the City as a covariate, it allowed non-linear effects to be considered, and achieved consistent results across numerous random seeds. Conclusion: The Random Forest algorithm is a suitable method to model case counts of Dengue Fever in China.

## P01. Built Environment, Noise and Greenness 1

### **P01.0250. The Association between Spatial Pattern of Green Space with High Vitality and Hyperthermia Mortality on the Extreme High Temperature**

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**Abstract:** Background/Aim We investigated the influence of spatial pattern of green space with high vitality, on hyperthermia mortality in South Korea, between 2004 and 2013. Methods We used remotely sensed data and geographic information to determine the amount of district vegetation. The landscape indices have been developed to evaluate the spatial patterns of green space with high vitality such as configuration and composition of patches. We analysed using a case crossover design for estimating the association between spatial pattern of green space with high vitality and hyperthermia mortality on the extreme high temperature by the quartiles of districts greenness [classified using the Normalized Difference Vegetation Index (NDVI)]. In our study, after investigating the vulnerable groups of the extreme high temperature, we examined the association between spatial pattern of green space with high vitality and hyperthermia mortality on the extreme high temperature, among the vulnerable groups. Results Our data showed that the relative risk of hyperthermia mortality at the high level of each index was lower than reference level, low level of each index, the number of patch and patch density (NP, PS). Also this pattern was significant statistically for those who were lower education level group and outdoor work occupations. Conclusions In this study, it showed that green spaces were reduced probability hyperthermia mortality, and spatial patterns as well as the amount of simple green spaces played an important role. The overall green area is wide, and one large patch is effective in lowering hyperthermia mortality.

## **P01.0260. Exploring the Utilitarian and Non-Utilitarian Bicycling Behaviors of North American Women Cyclists**

Huyen Le

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**Abstract:** Background: Increasing bicycling is a common goal to increase physical activity. Studies have shown that women bike at a lower rate than men due to various factors; few studies have examined attitudes and perceptions of women cyclists at a large scale. This study aims to fill this gap by examining the bicycling behaviors of women cyclists across North America. Methods: We analyzed an online survey of 1,868 women cyclists in the US and Canada. The survey recorded respondents' bicycling skills, attitude, perceptions of safety, surrounding environment, and other factors that may affect the decision to bicycle for transport and recreation. We used chi-squared and non-parametric tests to examine the differences among groups of cyclists. We then utilized tree-based machine learning methods (e.g., bagging, random forest, boosting) to select the most common motivations and concerns of these cyclists. Results: We found that perception of safety (e.g., traffic, motorist behavior, lighting) were significantly different among women cyclists across age groups, bicycling skill, and education levels. Tree-based model results indicate that perceptions of safety, wayfinding, bicycle facilities, hills, and concerns about health were among the most important factors for women to bike for transport or recreation. The average classification error rates were around 9-12%. Cross validation performed on 20% of the sample resulted in moderate error rates (9-25%). Conclusions: Our study suggests opportunities for designing healthy cities for women. Cities may enhance safety to increase bicycling rates of women through investing in bicycle facilities and lighting infrastructure as well as enforcing speed limits and aggressive behavior from motorists. Our study also outlines how promotional and education materials designed for women in the non-bicycling group may help to change behavior. Future studies to compare bicycling behaviors of cyclists and non-cyclists of both genders would be useful.

**P01.0280. Impact of the Built Environment on Active Travel: A Longitudinal Study of 12 U.S. Metropolitan Areas**

Huyen Le

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**Abstract:** Background: Increasing walking and bicycling rates is a common goal for cities to improve community health through physical activity and reduced emissions. Previous studies employed bicycle and pedestrian traffic count data to model spatial patterns of active travel; however, temporal trends have rarely been included in these studies since longitudinal traffic counts do not exist in most jurisdictions. We aim to address this limitation by examining the temporal trends and spatial patterns of active travel in 12 US metropolitan areas (MSA) across 12 years. Methods: We processed pedestrian and bicycle traffic count data from 2004 to 2016 (n=4,773 count locations; 12,832 observations) in the 12 MSAs. At each count location, we tabulated transportation, land use, and socio-demographic variables at three buffer sizes (300m, 500m, and 750m). We used two-level mixed-effect models to examine the multi-year trend and spatial patterns in bicycling and walking during morning and afternoon peak periods. Results: Our models suggest that active travel increased at a rate of 1-6% (bicycle) and 2-3% (pedestrian) per year. Built environment features were significant across models. Close proximity to university campuses, green space, water, and high density employment areas had a positive impact on active travel. The presence of bicycle facilities (e.g., bicycle lanes; off-street trails) were positively associated with higher levels of bicycle traffic. Inclusion of interaction terms suggests that locations with an off-street bicycle facility had a higher rate of increase in bicycle traffic over time. Conclusions: Our study provides evidence for the role of the built environment and transportation network in promoting active travel to increase physical activity and reduce emissions. Health researchers and practitioners could use our model results to quantify health impacts associated with how changes in the built environment and infrastructure influence rates of active travel.

## **P01.0290. Quantifying Residential Access and Exposure to Greenspace Using High-Resolution Remotely Sensed Data: A Case Study of Metro Vancouver, British Columbia**

Ingrid Jarvis

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**Abstract:** Despite growing evidence demonstrating the health benefits of greenspaces, the potential differences in effect depending on type of greenspace exposure remain relatively unexplored. The present research aims to develop a methodology to (1) identify greenspace using remotely sensed data and (2) model residential access and exposure to greenspace and the relative difference in vegetation type. **Methods:** 2014 RapidEye satellite imagery and LiDAR datasets from 2008-2015 were combined in eCognition for object-based segmentation, and then classified using Random Forest in R to produce a high-resolution (5m) land cover map of Metro Vancouver, Canada. The land cover map includes 14 classes - covering, for example, coniferous, deciduous, shrub, and grass-herb vegetation. Using the land cover map, greenspace access was calculated as the presence of a public park, recreation area or reserve ( $\geq 1$  hectare) within 300m of residential postal codes and greenspace exposure was calculated as the proportion of greenspace and each land cover type, within several buffer zones of residential postal codes. **Results:** The land cover map has an overall accuracy of 89% with a kappa of 0.88. Compared to traditional greenness metrics, such as NDVI, the land cover map provides a more detailed model of the variety and distribution of greenspace. Initial analyses suggest that more urbanized areas have greater access to public greenspace and higher exposure to built-up classes and broadleaf vegetation, with grass-herb vegetation increasingly dominant in rural and agricultural areas. **Conclusions:** This research presents a method of identifying and quantifying greenspace that can be applied widely. Differentiating greenspace access and exposure metrics, including relative distribution of land cover type, will help define which aspects and qualities of greenspaces may provide the most benefits. Such information will provide important guidance for prioritization in urban planning and public health policy.

## **P01.0291. Impacts of Multi-Modal Commuting on Personal Air and Noise Exposures and Airway Inflammation**

Yisi Liu

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**Abstract:** Background: Modern mobility can include mixtures of transportation options, which potentially impact pollution exposures and health. Objectives: To investigate variations in traffic-related air and noise pollution exposures and cardiorespiratory effects in different microenvironments in Chengdu, China. Methods: Three sections of a city were chosen as locations for a scripted exposure study: the urban core, a developing neighborhood, and a suburb. Exposures for four commuting modes (car, bus, subway, and shared bike) with overlapping routes were measured using portable instruments (measuring PM<sub>2.5</sub>, Black Carbon, and noise) in summer and winter (5 repeats in each season). We assessed the feasibility of collecting health measures (ECG, breathing rate, respiratory minute ventilation, fractional exhaled nitric oxide, and spirometry measurements) in winter for four healthy, non-smoking young adults. Health measures on commute days were compared to a control measurement collected two days after the last commute. Results: Air pollutant measures showed large seasonal variance, with winter medians more than three times higher than those in summer (PM<sub>2.5</sub>: 33 vs 123 ug/m<sup>3</sup>, BC: 2395 vs 9125 ng/m<sup>3</sup>). The highest PM<sub>2.5</sub> and BC levels were measured in the urban core (both  $p < 0.0001$ ). Noise tended to be higher in the summer, and was higher in the suburb than other neighborhoods ( $p < 0.0001$ ). In summer, riding the subway had the highest pollution levels, while riding a car was found to be the least polluted mode ( $p < 0.0001$ ). In winter, the highest air pollution levels were found for shared bike use ( $p < 0.0001$ ); subway and bus trips had the lowest PM<sub>2.5</sub> and BC level respectively ( $p < 0.0001$ ). Preliminary linear mixed modeling suggested that riding a car may be associated with increased airway inflammation ( $p = 0.004$ ). Conclusion: Results from this study suggest that mode, location and season of transportation impact personal traffic-related pollution exposure and airway inflammation.

**P01.0292. Assessing Associations between School Facility Condition, Neighborhood Environment, and Respiratory Health in Public Schools: An Application of Ultrahigh Dimensional Variable Selection Method on Big Data**

Yi Lu

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**Abstract:** Background: While poor school facility conditions were associated with impaired academic performance in large-scale studies, less research has assessed its health impact among students. Furthermore, strong correlations between variables made it difficult to assess a wide range of environmental factors in one model. In this study, we aim to assess the impact of school and home environmental factors on student's respiratory health in a multi-pollutant model by applying an innovative variable selection method. Method: A case-control study was conducted using statewide hospital records from patients aged 4 to 18 during 2010-2013 in upstate New York. Emergency department (ED) visits due to respiratory diseases were defined as cases, while visits due to gastrointestinal diseases, injury, and appendicitis were used as controls. Each patient was assigned to a school based on the information on patient's age, home address, and school zones. A set of 128 variables indicating school facility conditions and school or home neighborhood environmental hazards were included in the variable selection process. Iterative sure independence screening was applied to construct the final multi-pollutant regression model. Result: Eighteen environmental factors were chosen for the final model, including 11 indicators of school facility conditions and 7 indicators of traffic/industrial emission around the school/home. The strongest associations were found between respiratory ED visit and conditions of tile floor, foundation type, noise from air-conditioning or traffic, PM2.5 level in home neighborhood, active leak in classroom, and heating fuel system (increased risks ranged from 9% to 17%). Conclusion: Application of advanced variable selection method allows construction of multi-pollutant models with wide range of environmental factors. Specific school facility conditions potentially play a crucial role in student's respiratory health even after controlling for neighborhood environment.

## **P01.0300. Noise Sensitivity and Annoyance in the HERMES Cohort of Swiss Adolescents**

Louise Tangermann

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**Abstract:** The World Health Organization considers children at particular risk of suffering negative consequences from noise exposure. Knowledge on noise needs to be generated to prevent future harm. This study examines noise sensitivity and annoyance in the HERMES cohort of 892 adolescents in Switzerland. Noise annoyance and sensitivity were measured through questionnaires in adolescents aged 10 to 17, with a follow-up one year later. Participants rated annoyance to five noise sources: road traffic, railway, aircraft, industry, and neighbourhood noise, resulting in a binary score: no (none, little) and yes (clearly, severely). Sensitivity to noise was measured with the Zimmer/Ellermeyer scale, scores ranging from 0 to 27. Scores >14 indicated increased noise sensitivity. The proportions of noise sensitive and noise annoyed participants were calculated. Generalized estimating equations were used to investigate gender and age differences, adjusted for repeated measurements and overall time trend. The exposures to the noise sources were not considered in this analysis. At baseline, 846 students filled out the questionnaire, with 805 participating in the follow-up (participation rate: 95.2%). 24.1% of participants were noise sensitive. The proportions of participants annoyed by the noise sources were: 3.6% (road traffic), 2.0% (railway), 2.7% (aircraft), 1.9% (industry), and 6.7% (neighbourhood). No age and gender differences were observed, except for more males being annoyed by industry noise ( $p=0.019$ ) and more females being annoyed by neighbourhood noise ( $p=0.022$ ). Our study found a quarter of surveyed adolescents being noise sensitive, while the prevalence of annoyance by specific noises was relatively low. This analysis only considered psychometric data: noise experience and the relating personal trait. Future analyses will explore the relationship between these and the actual noise exposure, as well as other health outcomes such as behaviour, cognitive function and symptoms.

## **P01.0310. Long-Term Exposure to Wind Turbine Noise and Incidence of Myocardial Infarction: The Danish Nurse Cohort**

Jeanette Jørgensen

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**Abstract:** Introduction: Growing evidence supports the idea that traffic noise (road, rail and air) leads to long-term health complications other than annoyance, including myocardial infarction (MI), and similar effects may be expected from wind turbine noise. We examined the association between long-term exposure to wind turbine noise and incidence of MI. Methods: We used the Danish Nurse Cohort with 28,731 female nurses (>44 years) recruited in 1993 or 1999 from entire Denmark, and obtained data on incidence of MI from the National Patient and Causes of Death Registries until 2013. The noise from all wind turbines within a 6000 meters radius within nurses residence between 1982 and 2014 was estimated by Nord2000 method, as the annual mean of a weighted 24-hour average (Lden) at the most exposed façade. We used time-varying Cox regression to link the baseline year mean, 11-, 5- and 1-year moving averages of noise levels to MI incidence. Results: Of 23,994 nurses in the analyses 727 developed MI until 2013. There were 5,601 wind turbines in operation in Denmark between 1982 and 2013, and number of nurses exposed ( $\geq 1$  wind mill within 6000m radius from home) to wind turbine noise was 10% at the cohort baseline in 1993 or 1999, and increased to almost 25% in 2013. Compared to non-exposed nurses at the cohort baseline, we found positive associations with annual mean residential level of wind turbine noise and MI incidence, with hazard ratio (95% confidence intervals) for noise <21.5 dB: 1.29 (0.81-2.03); 21.5-25.4 dB: 1.79 (1.21-2.62); 25.4-29.9 dB: 1.12 (0.70-1.79), and > 29.9 dB: 1.02 (0.62-1.67). Similar pattern and weaker associations were observed with 11-, 5-, and 1-year moving averages, with strongest associations in second quartile of exposure. Conclusion: We found a suggestive evidence of an association between wind turbine noise and MI, but relatively small number of exposed subjects and MI cases, and lack of dose-response relationship demand more studies.

## **P01.0311. Associations of Surrounding Green, Air Pollution and Traffic Noise with General and Mental Health**

Jochem Klompmaker

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**Abstract:** Background: Several studies showed indications that mental health is affected by environmental exposures. Objectives: To evaluate the effects of combined exposure to surrounding green, air pollution and traffic noise with general health and aspects of mental health. Methods: We linked a Dutch national health survey of 387,195 adults with an external database on prescription of anxiolytics (N05B), hypnotics and sedatives (N05C) and antidepressants (N06A). Moreover, we added data on surrounding green based on the Normalized Difference Vegetation Index (NDVI) or a land-use database (TOP10NL), annual average air pollutant concentrations (including particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), and nitrogen dioxide (NO<sub>2</sub>) and road- and rail-traffic noise to the survey. We used logistic regression models to analyze associations of surrounding green, air pollution and noise exposure with self-reported general and mental health and medication prescription. Results: In single exposure models, exposure to air pollution was positively associated with all outcomes, while surrounding green was inversely associated with all outcomes. For example, for prescription of anxiolytics, we found an odds ratio [OR] of 0.83 (95% CI: 0.79, 0.88) per interquartile range [IQR] increase in green (TOP10NL) in a 1000m buffer and an OR of 1.14 (95% CI: 1.14, 1.19) per IQR increase in NO<sub>2</sub>. Road-traffic noise was only associated with prescription of anxiolytics (OR: 1.05 per 5 dB, 95% CI: 1.02, 1.07). Two-exposure analyses showed that the associations with surrounding green and air pollution generally remained, but they were attenuated. Conclusions: Surrounding green and air pollution were associated with general health and aspects of mental health.

**P01.0312. The Association between Long-term Neighborhood Greenness and Lethal Prostate Cancer in a Prospective Cohort Study of Male Health Professionals in the United States**

Hari Iyer

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**Abstract:** Background Emerging literature documents health benefits of natural environments. We studied the association between neighborhood greenness and 26-year incidence of lethal prostate cancer (CaP), effect modification by address type (home or workplace), and mediation by vigorous physical activity. Methods Participants in the Health Professionals Follow-up Study, a nationwide prospective cohort, were followed from 1986 to 2012. We excluded those with history of CaP or missing address. Lethal CaP was defined by metastasis or CaP death. Neighborhood greenness was measured using normalized difference vegetation index (NDVI) with 1km<sup>2</sup> resolution. Participants were assigned NDVI corresponding to their address at start of follow-up, taking averages over four seasonal measures. NDVI was modeled using quintiles. Data were analyzed using sequentially adjusted Cox regression models: 1) age, calendar year, race, family history, smoking, BMI at 21, PSA screening, census median income and home value, walkability index; 2) vigorous and non-vigorous physical activity, current BMI. Results 46,494 participants met eligibility criteria. Men in greener neighborhoods at baseline experienced lower rates of lethal CaP (model 1: Q2 v Q1, aHR: 0.84, 95% CI: 0.67-1.05; Q3 aHR: 0.86, 95% CI: 0.69-1.07; Q4 aHR: 0.77, 95% CI: 0.61-0.97; Q5 aHR: 0.86, 95% CI: 0.69-1.09, ptrend=0.11). Protective associations were strongest among men (39%) reporting work addresses (Q2 v Q1, aHR: 0.73, 95% CI: 0.51-1.02; Q3 aHR: 0.61, 95% CI: 0.42-0.89; Q4 aHR: 0.55, 95% CI: 0.37-0.83; Q5 aHR: 0.65, 95% CI: 0.42-1.00, ptrend=0.0005). Further adjustment for mediators (model 2) did not change effect estimates. Conclusions Our findings suggest a protective association between neighborhood greenness and lethal CaP independent of physical activity, though overall results were not statistically significant. Stronger associations at work suggest benefits may arise from passive rather than active engagement with nature.

**P01.0313. Associations between Traffic-Related Air Pollution and Cardiovascular Disease Risk Factors Were Stronger in More Walkable Neighborhoods: The Cardiovascular Health in Ambulatory Care Research Team (CANHEART) Cohort**

Nicholas Howell

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**Abstract:** Introduction Studies suggest living in a more walkable neighborhood may protect against cardiovascular disease risk factors such as hypertension (HTN) and diabetes mellitus (DM) by encouraging physical activity. Walkable neighborhoods, however, often carry higher levels of traffic-related air pollution. Little is known regarding whether synergistic effects may exist between walkability and air pollution on these risk factors. Hypothesis We hypothesized that the association between traffic-related air pollution, hypertension, and diabetes mellitus would be stronger in more walkable areas. Methods We drew a cross-sectional sample of individuals ages 40-74 on January 1, 2008 from the CANHEART cohort. HTN and DM were ascertained using validated algorithms. Walkability (quintiles, Q5 highest, Q1 lowest) was measured using a validated index which has previously been shown to be inversely associated with obesity and diabetes. Exposure to nitrogen dioxide, a valid marker for traffic-related air pollution, was assessed using a land use regression models. The associations were tested using logistic regression with cluster-robust standard errors, adjusting for age, sex, area-level income, ethnicity, and comorbidities. Results 2,618,584 individuals were included in the analysis. Walkability was inversely associated with odds for HTN (Q5 vs. Q1 OR = 0.80, 95% CI: 0.79, 0.82) and DM (Q5 vs. Q1 OR = 0.89, 95% CI: 0.87, 0.91), while NO<sub>2</sub> was positively associated with each (HTN: OR = 1.02 per 10 ppb (1.01, 1.03); DM: OR = 1.11 per 10 ppb (1.09, 1.13)). We observed significant interactions between walkability and NO<sub>2</sub> on odds for HTN and DM, with stronger NO<sub>2</sub> associations in the most walkable neighborhoods. Conclusions We observed significant interactions between traffic-related air pollution and walkability on odds for HTN and DM. This finding suggests that benefits from living in more walkable neighborhoods may be partially offset by stronger negative associations with air pollution.

## **P01.0314. The Relationship between Long-term Exposure to Neighbourhood Greenness and Air Pollution and Cardiovascular Mortality in Urban Areas in Belgium**

Mariska Bauwelinck

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**Abstract:** Background Few large-scale studies have evaluated the association between residential green, air pollution and cause-specific mortality. Our study investigates the relationship between long-term residential exposure to green spaces, air pollution and cardiovascular (CV) mortality in adults living in the five largest cities in Belgium. Methods We used the Belgian 2001 census linked to mortality follow-up data (2001-2011) among 18 to 65-year-old adults for the 5 largest cities in Belgium. The data contain individual information on CV mortality (ICD-10 codes I10-I70), sociodemographic variables (age, sex, education level, employment status and housing status), residential history (based on the link with the 1991 census) and annual means ( $\mu\text{g}/\text{m}^3$ ) of air pollution (PM10, PM2.5, NO2 and BC) for the residential addresses. Different measures of green (percentage (+ 600m buffer), proximity and fragmentation of green) based on land use data (CORINE land cover) were available at the scale of census tracts. Cox proportional hazards models, where age was used as the underlying time scale, were performed to probe into CV mortality. Results We studied  $\approx 2$  million adults with 10.25 years of follow-up and observed  $\approx 11,200$  CV deaths. Consistent statistically significant effects were found for the different measures of green in the adjusted models. Hazard ratio's for the % of neighbourhood green per increase in IQR and % of green within a 600m buffer were 0.969 (99% CI 0.952-0.987) and 0.866 (99% CI 0.830-0.905), respectively. Results show independent effects for the measures of green on CV mortality when adjusted for the different pollutants separately. Sensitivity analyses including only non-movers showed similar results. Conclusion Our results suggest a beneficial association between exposure to residential green and CV mortality. Further analyses will be conducted within this study to confirm our results.

## **P01.0315. Modelled and Perceived Noise Exposure and Psychotropic Medication Use**

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**Abstract:** Background Road-traffic noise can induce stress which may eventually lead to mental health disorders. Mental health problems of noise have not are scant in research. People perceive noise differently, this may affect the extent to which noise contributes to poor mental health at individual level. This paper aimed to assess relationships between perceived or modelled noise and use of psychotropic medication. **Methods** We conducted a survey to evaluate perceived exposures of residents of the Helsinki Capital Region of Finland to road-traffic noise and the associations of these exposures with sleep disorder, anxiety and depression. Respondents were randomly sampled from the Finnish Population registry and data was collected using a self-administered questionnaire. Associations between subjective (annoyance) or modelled façade-noise levels and mental health outcome indicators were assessed using generalised additive models while controlling for socioeconomic, lifestyle and exposure-related factors. **Results** A total of 7321 respondents returned completed questionnaires. The proportion of respondents with self-rated moderate to severe road-traffic noise exposure showed a linear trend with higher categories of modelled noise. About 15%, 7% and 7% of respondents used sedative, anxiolytic and antidepressant medicaments, respectively, in the year prior to the study. Perceived noise exposure was clearly associated with anxiolytic drug use only, OR=1.41 (95% CI: 1.02 – 1.95). There was suggestive association between modelled noise and anxiolytic or antidepressant use. In respondents without a quiet façade, modelled noise was more definitively associated with antidepressant use. Noise sensitivity did not modify the effect of noise but was independently associated with increased use of all medication. **Conclusion** We observed few associations between noise and psychotropic medication use. Noise sensitivity was found to predict psychotropic medication use independently of noise.

**P01.0316. Long-Term Residential Exposure to Environmental Noise and Cardiovascular Disease Onset: A Population-Based Cohort Study**

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**Abstract:** Introduction: Cardiovascular effects of environmental noise are a growing concern. However, the evidence remains largely limited to the association between road traffic noise and hypertension and ischemic diseases especially myocardial infarction (MI). Objective: To examine associations between long-term residential exposure to total environmental noise and the onset of cardiovascular MI and strokes in adults of the Island of Montreal. Methods: An open cohort of 1,087,806 adults aged  $\geq 45$  years, free of MI and strokes before entering the cohort was created for the years 2000 to 2014 with the Quebec Integrated Chronic Disease Surveillance System, a systematic surveillance system from the second most populous province in Canada starting in 1996. The exposure to total environmental noise (L<sub>Aeq24h</sub>) at cohort entry was estimated with a Land Use Regression (LUR) model. Onsets of MI and strokes were based on one hospital admission. Cox models were used to estimate associations. Results: We found positive associations between L<sub>Aeq24h</sub> estimated and the occurrence of MI and strokes; hazard ratios adjusted for age, sex, year of entry, social and material deprivation indexes and traffic-related air pollutant (nitrogen dioxide) were respectively 1.10 (95% CI: 1.07-1.13) and 1.06 (95% CI: 1.03-1.09) per 10 dBA. Conclusion: These results suggest that total environmental noise is associated with the onset of MI and strokes. Future work should clarify if associations vary by noise sources, and if pre-existing diseases (e.g. hypertension) mediate such effects.

## **P01.0317. Long-Term Transportation Noise Exposure and Incidence of Ischemic Heart Disease and Stroke**

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**Abstract:** Background Exposure to transportation noise is widespread and has been suggested as a risk factor for cardiovascular disease. However, the evidence from longitudinal studies on ischemic heart disease (IHD) and stroke is limited. This cohort study aimed to estimate the association between exposure to noise from road traffic, railways or aircraft and incidence of IHD and stroke. **Methods** We assessed individual long-term exposure to road traffic, railway and aircraft noise based on residential histories in a cohort of 20,012 individuals. The National Patient and Cause-of-Death Registers were used to define IHD and stroke events. Extensive information on potential confounders was available from questionnaires and registers. We computed Hazard Ratios (HR) using Cox proportional hazards regression to assess associations between noise exposure and IHD. **Results** The study base of 245,000 person-years generated 1,363 and 902 incident events of IHD and stroke, respectively. We observed a particularly high risk of IHD in those exposed to all three transportation noise sources at  $\geq 45$  dB Lden, with a HR of 1.57(95%CI 1.06–2.32), and a similar tendency for stroke (HR 1.42; 95%CI 0.87–2.32). While no associations were observed between noise exposure from any of the sources and incidence of IHD or stroke, there were associations between road traffic and aircraft noise exposure 1-5 years prior to the event and IHD incidence in women, with HR of 1.11(95%CI 1.00–1.22) and 1.25 (95%CI 1.09–1.44) per 10 dB Lden, respectively. On the other hand, a decreased risk of IHD was seen for men in relation to road traffic noise exposure (HR 0.86; 95%CI 0.79–0.94 per 10 dB). **Conclusion** No overall associations were observed between noise exposure from different transportation noise sources and incidence of IHD or stroke. However, there appeared to be an increased risk of IHD in women exposed to road traffic or aircraft noise as well as in those exposed to multiple sources of transportation noise.

## **P01.0318. Modeled and Perceived RF-EMF, Noise, Air Pollution and Symptoms in a Population Cohort: Is Perception Key in Predicting Symptoms?**

Marije Reedijk

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**Abstract:** Introduction Psychosocial research has shown that perceived exposure can influence symptom reporting, regardless of actual exposure. The impact of this phenomenon on the interpretation of results from epidemiological research of environmental determinants on self-reported health is unclear. Methods In this study we compared associations between modeled exposures, the perceived degree of being exposed to these exposures and reported symptoms (non-specific symptoms, sleep disturbances, respiratory symptoms) for three environmental exposures (radiofrequency electromagnetic fields (RF-EMF), noise, and air pollution) which vary in the degree to which they can be sensorially observed. Participant characteristics, perceived exposures, and self-reported health were assessed with baseline (n=14829, 2011/2012) and follow-up (n=7905, 2015) questionnaires in the Dutch population-based Occupational and Environmental Health Cohort study (AMIGO). Environmental exposures were estimated at the home address using spatial models. Cross-sectional and longitudinal regression models were used to examine the associations between modeled and perceived exposures, and reported symptoms. Results The extent to which exposure sources could be observed likely influenced correlations between modeled and perceived exposure as correlations were moderate for air pollution (rSp=0.34) and noise (rSp=0.40), but less so for RF-EMF (rSp=0.11). Perceived exposures were consistently associated with increased symptom reporting (non-specific, sleep, respiratory). In general, modeled exposures were associated with increased symptom reporting, but these associations were strongly attenuated when perceived exposure was accounted for in the analyses. Discussion Perceived exposure has an important role in symptom reporting. Evaluations of environmental determinants of symptom reporting may result in biased estimates if exposure perception is not taken into account.

## **P01.0319. Human Responses to Biophilic Indoor Environment**

Jie Yin

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**Abstract:** Biophilic design, which incorporates natural elements into the built environment, has received increasing attention in both design and health fields. Epidemiological and experimental studies have provided sufficient evidence that contact with outdoor nature has positive impacts on human health and wellbeing. However, the potential for similar health benefits in indoor biophilic environments remains unclear. We designed a randomized crossover study to examine the physiological and cognitive responses to biophilic indoor environments by using virtual reality (VR) and wearable bio-monitoring sensors. In this study, 28 participants spent time in an indoor environment featuring biophilic design elements and one without, with the order of the visit randomized. In each visit, they experienced the same environment for 5-minutes in reality and virtually by using VR. The indoor biophilic environment was associated with a decrease in participants's blood pressure. The overall differential effects for participants experiencing an indoor environment with biophilic elements versus none was 8.56 (95%CI: 5.60-11.52) mmHg lower systolic and 3.57 (95%CI: 0.36-6.78) mmHg lower diastolic blood pressure. In addition, their skin conductance decreased by 0.18 (95%CI: -0.004-0.36)  $\mu$ S and short-term memory improved by 14% (95%CI: 5.3%-23.2%). Moreover, our findings indicate that participants had similar physiological and cognitive benefits in the virtual environment and actual environment. The results indicate that biophilic environment may be beneficial in reduce stress in indoor settings. Additionally, the parity in results in virtual and real environments provides evidence that using VR can be an effective tool to simulate visual exposures when access to the real environment is not feasible.

## P01. Exposure Measurement, Modeling and Other Methodological Issues 1

### P01.0320. Development of Sensor Metadata Library for Exposomic Studies

Ramkiran Gouripeddi

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Abstract: Exposomic research may utilize multiple sensors to measure individuals' environment and their physiological responses. These sensors measure physical, chemical and biological properties and have wide variations in their capabilities and performance. It is therefore important to provide sensor characterization information in order to make appropriate decisions when selecting and utilizing sensors for research studies and analysis or when performing meta-studies aggregating data from multiple sensors. In this presentation, we discuss the development, organization, and use of a sensor metadata library (SML) developed by the Utah PRISMS Informatics Ecosystem (UPIE) (Grant NIH NIBIB U54EB021973). We performed a needs assessment and utilized the sensor common metadata specifications (SCMS) developed by UPIE in designing the SML. SCMS contains sensor metadata pertaining to the physical device, their deployment and resulting measurement outputs. The SML includes domains describing the physical characteristics of devices, including hardware and software versioning, measurement and/or sample collection characteristics, validation protocols, ownership and additional technical documentation. We implemented the SML using the NeO4j graph database. The SML includes tools for capturing and discovering metadata for new and updated versions of sensors. Sensor owners can submit metadata to the SML using a REDCap survey form, which is then curated and stored. Researchers can visualize stored sensor metadata graphically as interlinked nodes of information. This SML serves as a researcher-facing tool - as a repository of sensor information for researchers to design their exposomic studies and understand their limitations; and an inventory of available sensors for prospective study deployments. It also serves as a source of metadata store for the UPIE for performing semantically consistent metadata driven integration of heterogeneous sensor data streams for exposomic study analysis.

## **P01.0330. Advancing Study Metadata Models to Support an Exposomic Informatics Infrastructure**

Victoria Tiase

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**Abstract:** Exposomic research is an emerging field of study that seeks to address environmental exposures and its effects on life, health, and disease development. Research using exposomic data includes those related to the research and development of sensor devices, chemistry of environmental species and exposure pathways. Concurrently, with the increase in biomedical research interests and advances in exposome data collection, data are increasingly available.<sup>1</sup> In order to support such translational exposomic studies, there is a need for an informatics infrastructure along with tools to facilitate access and use by investigators. However, to date, there is no standard or systematic way to model a translational exposomic research study. To support research using personalized and environmental sensor devices, we developed a model for exposomic studies to cover the design, conduct and analytic phases of a study. We reviewed existing study metadata representations and compared them with a sample of publicly available exposome studies from the literature and others elicited from researchers. Gaps were found in how sensor data are represented in the existing study metadata models and in general, a lack of detail into data requirements for exposome studies; all needed for an informatics infrastructure. To address these gaps we consolidated data elements from existing domain specific models. In particular, we incorporated the Sensor Common Metadata Specification (SCMS) into the model. The SCMS is currently being implemented in the Utah PRISMS Informatics Ecosystem (UPIE) and includes metadata of measured data from sensors, the deployment of sensors, and the sensors itself.<sup>2</sup> This model is currently being validated within UPIE for reproducible representations of exposomic studies, and computable specification of study data integration, to support the study of effects of the environment on health and advance the science in this area.

## **P01.0340. Metal Concentrations in Electronic Cigarette Aerosols: Effects of Device Type and Vaping Patterns**

Di Zhao

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Abstract: Electronic cigarettes (E-cigarettes) generate an aerosol that contains metals. Little is known about the effects of device type and vaping patterns on metal exposure. The objectives of this study were (1) to quantify concentrations of 14 metals in aerosol generated by four types of e-cigarettes including two mods (Istick 25 and SMOK) and two pods/cigalikes (BLU and JUUL) and (2) to examine the effects of device type, device power, flavor (tobacco, menthol, fruit, and others), nicotine content, and coil aging on metal emissions. The mods were operated at three power settings. Two new and two used coils were used to examine the effects of coil variability and aging with pale whale flavored e-liquid. In total, 160 aerosol samples were obtained and analyzed. Median metal concentrations ( $\mu\text{g}/\text{kg}$ ) in aerosol generated by each of the two mods were: 3.02 and 20.8 for Cr, 134 and 542 for Cu, 118 and 153 for Fe, 19.6 and 64.0 for Mn, 862 and 2,252 for Ni, 123 and 541 for Pb, 318 and 20.9 for Sn, 3,432 and 3,114 for Zn. Median metal concentrations ( $\mu\text{g}/\text{kg}$ ) in pods/cigalikes were markedly lower than in mods: 0.39 and 0.41 for Cr, 31.0 and 6.02 for Cu, 0.08 and 0.08 for Fe, 0.80 and 0.39 for Mn, 1.32 and 11.9 for Ni, 6.88 and 0.88 for Pb, 0.80 and 0.01 for Sn, 1,247 and 683 for Zn. Metal concentrations depended on power, flavor, nicotine content, and coil age. Device type and vaping patterns had great impact on the levels of harmful metals in the aerosol. Aerosolized metal exposure from e-cigarettes can potentially be reduced though not eliminated if strict e-cigarette manufacturing standards are established.

## **P01.0350. Aggregate Exposure Estimation of Di(2-Ethylhexyl)phthalate in Multiple Cosmetic Products**

Miyoung Lim

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Abstract: In order to estimate the realistic exposure of a chemical, aggregate exposure from multiple consumer products should be considered. Typical aggregate exposure assessment was a form of the simply combined amount of exposure by product. Accurate aggregate exposure assessment should be based on individual's exposure factors and actual chemical contents in products. The aims of this study were to estimate aggregate exposure of Di(2-ethylhexyl)phthalate (DEHP) in multiple cosmetic products by Korean population group and determine the contribution of each product. We collected the exposure factors of 12 cosmetic types (four skincare, three hair care, three body care, and two cleansing products). Field survey staff visited homes and collected product use information using face-to-face interview. In total, 1,001 subjects over 19 years old completed the questionnaire from June to August 2017. The number of subjects was determined by proportionate quota sampling based on the population composition ratio in sex and age distribution. DEHP concentrations for 111 products from the 12 product categories were analyzed by GC-MS/MS. The exposure factor survey showed that 96.4% of the 1,001 subjects used at least one cosmetic product. The detection frequency of DEHP in the cosmetic products was 61.3% and maximum concentrations were 18.6 µg/g at 34 skincare, 24.0 µg/g at 15 hair care, 122.9 µg/g at 23 body care and 75.2 µg/g at 39 cleansing products. The average aggregate DEHP exposure based on individual's exposure factors was  $2.97 \pm 4.00$  µg/kg-bw/day in Korea population. The 30's women group was the group of the highest aggregate DEHP exposure with  $5.21 \pm 6.17$  µg/kg-bw/day which was 6.86 times higher than 60's men group. DEHP exposure contribution by products was in order of body cream, facial cleanser and facial cream. These aggregate exposure data would be useful input data for risk assessment and regulation of DEHP in cosmetic products.

## **P01.0360. An Extended Random-Effects Framework for Meta-Analysis in Environmental Research**

Antonio Gasparrini

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**Abstract:** Background and aim: Two-stage designs have become standard tools in environmental epidemiology. These methods rely on the application of a random-effects meta-analysis to pool results from different locations. However, standard models do not account for potential correlation structures within and between locations, arising for example when pooling multi-parameter associations, multiple levels or hierarchies, and/or longitudinally and spatially-correlated estimates. In this contribution, we illustrate a unified framework and software for meta-analysis that flexibly extends the two-stage design to cover these and other applications. Methods: We extended the standard meta-analytic models along the lines of linear mixed-effects models, by allowing correlation between effect sizes to be modelled through a flexible random-effects structure. We derived (restricted) maximum likelihood estimators, and efficient computational strategies based on profiled methods alternating iterative generalized least squares and Newton-Raphson procedures. The analytic framework and inferential procedures are implemented in a new version of the R package *mvmeta*. Results: The modelling framework and its software implementation will be illustrated in a series of examples, using multi-city time series data for the analysis of health effects of air pollution and temperature. Various case studies will demonstrate different applications, such as: multilevel meta-analysis of effects across locations nested within countries; meta-analysis for spatially-correlated outcomes; longitudinal meta-analysis for repeatedly-measured effects to assess effect modification by time-varying predictors, such as air conditioning. Conclusions: The definition of a unified framework for meta-analysis, along with a freely-available software, will provide researchers with a flexible tool for addressing non-standard pooling problems in two-stage designs applied to environmental studies

## **P01.0370. Silicone Cat Tags Detect Feline Flame Retardant Exposures**

Carolyn Poutasse

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Abstract: Since the first clinical diagnosis in 1979, the prevalence of feline hyperthyroidism in the United States has increased from 1 in 300 to 1 in 10 domesticated geriatric cats. Similar prevalence statistics are reported worldwide. Although histologically similar to human toxic nodular goiter, the underlying causes of feline hyperthyroidism remain unknown. There is some evidence that exposure to endocrine-disrupting compounds with thyroid targets may contribute to the development of feline hyperthyroidism and toxic nodular goiter. This includes exposures to brominated flame retardants (FRs), such as polybrominated diphenyl ethers (PBDEs). FR exposure routes (e.g. inhalation) are the same between cats and humans, such that cats can be used as sentinels for human exposures. In this study, silicone passive sampling devices, or cat tags, quantitatively assessed the bioavailable fraction of household FRs. Participating cats wore a cat tag for 7 days, and targeted analysis by gas chromatography mass spectrometry included 41 legacy and current FRs. Preliminary data indicated that 3 non-hyperthyroid cat tags detected a total of 11 PBDEs and organophosphate ethers. Tris(2-chloroisopropyl)phosphate (TCPP), triphenyl phosphate, and BDE-47 were detected above the limit of quantitation in all 3 cat tags. TCPP was detected at the highest concentration in each tag, ranging from 1.35 to 32.3 ng/g cat tag. This study provides proof-of-concept data for the use of silicone cat tags with companion animals and demonstrates that cat tags can compare FR concentrations in homes of hyperthyroid and non-hyperthyroid cats.

## **P01.0380. Quantified Micro-Level Activity Data for Children Aged 1 - 12 Years Old Playing on Turf and Playgrounds**

Nicolas Lopez-Galvez

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Abstract: The use of synthetic turf in sport fields, parks, yards, and playgrounds in many communities is gaining popularity as a substitute to natural grass. However, there is growing concern regarding the exposure to toxicants released from recycled tire rubber, which is commonly used as an infill material in synthetic turf and playground mats. To better estimate the aggregate exposure and risk to recycled tire rubber used in synthetic turf and playground floors, there is a need to collect detailed information on mouthing activity and dermal contact behaviors. Thus, micro-level activity time series (MLATS) of children aged 1-12 years was analyzed to quantify these behaviors while children played on turf-like locations such as parks, yards, and playgrounds. MLATS data was extracted from a pre-existing dataset of 56 children playing outdoors. Hand and mouth contact frequency, hourly duration, and median contact duration with different objects were calculated for children playing on turf (n = 56), and for children playing on playground structures (n = 24). For children playing on turf, age was negatively correlated with mouthing activity for non-dietary objects. There were significant differences between younger (1-5 years old) and older children (6-12 years old) groups for the mouthing median duration with hands, non-dietary objects and all objects. Males had significantly higher hourly contact duration of both hands with non-dietary objects than females. For children playing on playground structures, although there were no significant differences between genders, there were significant differences between younger (1-5 years old) and older children (6-12 years old) groups for the mouthing frequency with non-dietary objects and all objects, and for mouthing median duration with non-dietary objects. In conclusion, age and contact duration should be considered in performing risk assessment models for mouthing activities when children are playing on artificial turf surfaces.

## **P01.0400. Evaluating Use of Digital PCR in Quantitative Analysis of Microbial DNA in the Indoor Environment**

Samuel Cochran

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Abstract: Previous methods of detecting and identifying bacteria and fungi in the built environment were reliant on culture-based methods. These methods cannot accurately quantify all microbes present in environmental samples and lead to underestimation of microbial exposures indoors, where we spend 90% of our time. The advent of quantitative polymerase chain reaction (qPCR) and digital PCR (dPCR) has substantially enhanced our ability to quantitatively measure microbial species so to better understand our exposure. While qPCR offers a larger dynamic range, dPCR, the newer technology, promises better repeatability and reproducibility with greater precision at low target copy numbers. For both technologies however, we need to better characterize the accuracy, precision, and reproducibility in use with indoor environmental samples. Another goal for this study is to determine extraction efficiencies in stages during sample analysis. Dust samples-spiked separately with *Escherichia coli*, *Bacillus atrophaeus*, and *Aspergillus fumigatus*-were collected from different carpet types. It was found that 96.57%, 92.88%, and 92.51% of total spiked *E. coli*, *B. atrophaeus*, and *A. fumigatus* DNA, were respectively recovered from low-pile carpet. From medium pile carpet, 84.42%, 81.37%, and 60.96% of total spiked DNA from each respective organism were recovered. The combined efficiencies, accounting for both 'carpet extraction' and DNA extraction, for *E. coli*, *B. atrophaeus*, and *A. fumigatus* (low pile, medium pile) were: 31.00%, 27.10%; 71.80%, 62.90%; and 17.30%, 11.40%. A substantial percent of DNA is unrecovered for all samples, but differs both between carpet type and organism. Therefore, it is necessary to consider extraction efficiencies not only for the characterization of qPCR and dPCR in analyzing indoor environmental samples, but also for calculating total microbial DNA concentrations in the environment, and for best estimating microbial exposures.

**P01.0410. Development of an In-Home Air Pollutant Sensor Platform and Implications for Community Use: Framework for Selection and Quality Control**

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Abstract: Characterization of environmental exposures has been shaped by logistical, technological and financial constraints resulting in passive or integrated campaigns that do not allow fine-scale measurement of short-term events relevant to health. Recent advances allow for continuous monitoring of pollutants using comparatively small, inexpensive, real-time sensors. Such sensors have been widely used in occupational settings, but transitions to use in lower concentration environments present quality control challenges. For the Center for Research on Environmental and Social Stressors in Housing across the Life Course (CRESSH), we developed a multi-pollutant air sampling platform-environmental multi-pollutant monitoring assembly (EMMA)-for in-home measurements aiming to develop innovative methods for improved estimates in between-household variability in environmental exposures. Of one- and five-minute data collected using EMMA-carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), particulate matter (PM<sub>2.5</sub>), temperature, relative humidity and noise-the following issues were identified and accounted for: inter-sensor variability, temperature effects and performance degradation. Gas sensors show notable initial performance (mean R<sup>2</sup>=0.99±0.005), but require constant performance scrutiny. Over 18 months, average CO sensor sensitivity decreased by 21% and NO & NO<sub>2</sub> by 36 & 30%, respectively, coinciding with differential signal at like concentrations over time. Modeling results from lab-based controlled experiments show NO & NO<sub>2</sub> data significantly biased at temperatures ≥93 & 90°F and below 40 & 50°F, respectively. Despite such issues, we achieved 97% data completeness. These findings may inform citizen science applications where various resources (e.g., calibration equipment, computer software) ensuring interpretable data may not be available. Our process of validating and maintaining EMMA may provide guidance for others seeking to develop and deploy such platforms.

## **P01.0420. A Mechanistic and Dynamic Air Quality Regression Model Featuring a Heterogeneous Wind Field**

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Abstract: Air pollution exposure assessment is often performed through the use of regression models. These models work well due to their data-driven nature and the inherent high fit between observed and modeled values. However, they are often linear and lack the physics needed to assess air quality at a high temporal resolution. Although it has become common practice to incorporate the predictions of mechanistic models as an additional explanatory variable in land-use regression, the dispersion parameters themselves are not regressed in these cases. In this work, we developed a non-linear air quality regression model which is loosely based on Gaussian dispersion. This model incorporates ambient air quality measurements, emission rates from industrial stacks, GPS-based assessment of traffic volumes and a detailed (1 km) wind field as its inputs. The trajectories of emission "puffs" from each source are tracked throughout the study area and their effects on each location are calculated. At each half-hourly time-point an optimal set of 10 model parameters are computed via a non-linear least-squares regression process. These parameters include a "background" uniform concentration, linear coefficients for each source type, non-linear parametrizations of the dispersion standard deviations and a first-order kinetics reaction rate coefficient. The developed model enables us to perform air pollution exposure assessment at a high spatio-temporal resolution. This assessment can be performed at any location which has the model inputs available for it, and without any adjustments of the model formulation. Preliminary cross-validation results indicate a superior performance to both an older version of this model (which did not include a heterogeneous wind field) and spatial interpolation.

**P01.0430. Environmental Exposure Induced Metabolic Profiling Alterations in a Migration Panel between Los Angeles and Beijing**

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**Abstract:** Migration provides individuals experiencing different environmental exposure episodes naturally, which offers a chance to attribute physiological response to certain exposure factors. To reveal the mechanism of health effect under environmental exposure, we designed a migration panel study between Los Angeles and Beijing, two cities with different exposure levels. Specifically, serum samples were collected from 27 summer school exchange students three times in total, one week before their departure (LA1), and at least four weeks respectively after their arrival to Beijing (BJ) and return to Los Angeles (LA2). The metabolic profiling was obtained through untargeted metabolomics approach with a high resolution TOF-MS. Combining with a series of statistical methods like Mann-Whitney test and Orthogonal partial least squares discriminant analysis, we screened prospective markers that changed significantly between LA and BJ. The significant decrease ( $p < 0.001$ ,  $FC > 1.2$ ) of indole and its precursor tryptophan in BJ reflected the induction of AhR and CYP by higher levels of pollutants. The decreased cortisol ( $p < 0.001$ ,  $FC > 1.5$ ) was potentially due to the accelerated consumption of CYP3A, supplying further evidence of enhanced CYP activity and related xenobiotics elimination in BJ. On the other hand, the increase of IL-8 and IL-10 from cytokine analysis suggested the oxidative stress during the process. A slightly higher level of uric acid ( $p < 0.01$ ,  $FC > 1.1$ ) along with its precursors implied the upregulation of antioxidation under the environmental exposure in BJ. Generally, this study illustrated that metabolomics offered an effective tool to assess the overall health impact under subchronic exposure.

## **P01.0440. Monitoring Chemical Contamination of Medical Air Produced On-Site in a Healthcare Institution Using Low-Cost Air Quality Sensors**

Hosna Movahhedinia

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Abstract: Medical air is used in hospitals for patients suffering from a wide range of conditions. This air is typically produced by pressurizing outdoor air on-site and supplying it to patients through a lengthy piping system. Thus, it may contain chemical pollution from outdoor sources, line contamination, or technical problems within the compressor system. Hospitals in North America are mandated to meet medical air quality standards established by the United States Pharmacopeia (USP), yet its quality is often unmonitored. Further, USP limits for many pollutants common in ambient air are unspecified while specified limits for some pollutants are far higher than common ambient air quality standards even though this air is intended for potentially vulnerable individuals. Finally, patient exposure is not determined and thus generally unknown. In this study a sensor-based air quality monitor was used in conjunction with portable instruments to measure the concentration of CO, CO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub>, black carbon (BC), and ultrafine particles (UFP). Simultaneous measurements were made at the outdoor intake to the compression system and at the patient-room end of pipelines at a Canadian hospital. The results show a strong association between outdoor air pollution and the medical air quality for some pollutants, based on correlation analysis. The concentrations of CO and CO<sub>2</sub> in the medical air were close to outdoor levels and followed the time-related changes in the outdoor concentrations. In contrast, the concentrations of NO<sub>x</sub> and O<sub>3</sub> were lower than outdoor levels, and BC and UFP levels were generally below detection limit. Although the chemical pollutant concentrations were below the USP standards, this study indicates that outdoor sources of air pollution can strongly influence the chemical contamination of medical air.

## **P01.0450. Impact of Smart Home Portable Air Purification on Average and Peak PM2.5 Concentrations in Small Urban Residences**

Erika Eitland

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Abstract: Sensor-activated, dynamic portable air purifiers are a part of a growing market of smart home technologies aimed at improving energy efficiency and health. For vulnerable populations such as children, elderly and individuals with a pre-existing condition, air purification may reduce daily exposure to harmful concentrations of fine particles. Some new air purifiers are sensor activated such that filtration is triggered by air quality conditions in the space; however, the effectiveness of these 'smart home' purifiers compared to traditional air purification has not been evaluated in a real-world setting. In summer 2017, a crossover study was completed in small urban residences (n=32), which compared the change in continuous particulate matter less than 2.5 microns in diameter (PM2.5) concentrations across three intervention arms: 1) No Air Purification, 2) Smart Home Purification and 3) Continuous Purification. Overall, continuous purification significantly reduced average PM2.5 compared to baseline and smart home conditions by 1.171  $\mu\text{g}/\text{m}^3$  and 1.210  $\mu\text{g}/\text{m}^3$  respectively. However, the average duration participants were exposed to concentrations above 30  $\mu\text{g}/\text{m}^3$ , the activation threshold for the device used in the study, was shortened by 60.8 minutes and 43.8 minutes with Smart Home purification compared to baseline and continuous filtration, respectively. The implication of these findings is that Smart Home purification can reduce peak exposures to PM2.5, but may lead to higher cumulative exposures at lower levels compared to continuous filtration. As a result, Smart Home purification may be best suited to reduce exposures during acute PM2.5-emitting events such as cooking or rush hour traffic.

**P01.0460. Pilot Study of the Enhanced Children's MicroPEM Compared to the Standard Gravimetric Methods to Measure Personal Exposure and Kitchen Concentrations to Fine Particulate Matter from Household Air Pollution: HAPIN Trial Investigators**

Vanessa Burrowes

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**Abstract:** Background: The HAPIN four-country randomized trial seeks to evaluate the effects of liquefied petroleum gas stoves and fuel distribution intervention on health outcomes. Adequate assessment of personal PM<sub>2.5</sub> exposure is critical for both understanding intervention effectiveness and building exposure-response relationships. Since standard gravimetric pump and cyclone/impactor approaches for personal PM<sub>2.5</sub> assessment are heavy, noisy, and bulky, they are unsuitable for children and burdensome to adults. In a pilot study, we compared the performance of a next-generation exposure monitor [Enhanced Children's MicroPEM (ECM), RTI International, Raleigh, NC] to standard gravimetric methods. Methods: We co-located standard gravimetric pumps and cyclone/impactors with ECMs to obtain 24- and 48-hour kitchen PM<sub>2.5</sub> concentrations and corresponding personal exposures in Guatemala, India, Peru, and Rwanda in homes with a range of exposures. Specific sampling approaches varied across centers due to logistics. Bland-Altman plots were used to assess agreement in mean PM<sub>2.5</sub> between devices. Results: Using 124 personal samples and 102 kitchen samples, average PM<sub>2.5</sub> concentrations measured by standard gravimetric methods and the ECM were 97.7 µg/m<sup>3</sup> (range: 2.1-585.9 µg/m<sup>3</sup>) and 108.5 µg/m<sup>3</sup> (range: 9.6-516.5 µg/m<sup>3</sup>), respectively. The mean difference between the ECM and standard gravimetric approach was -10.8 µg/m<sup>3</sup> (95% CI: -151 to 129 µg/m<sup>3</sup>). Lastly, there was no substantial proportional bias in assessment of PM<sub>2.5</sub> concentration at any level [mean difference 0 to 49.9 µg/m<sup>3</sup>: -20.1 µg/m<sup>3</sup> (95% CI: -96.5 to 56.2 µg/m<sup>3</sup>); mean difference 50.8 to 99.4 µg/m<sup>3</sup>: -22.2 µg/m<sup>3</sup> (95% CI: -163.2 to 118.7 µg/m<sup>3</sup>); mean difference 107.2 to 585.9 µg/m<sup>3</sup>: 10.95 µg/m<sup>3</sup> (95% CI: -196.6 to 218.5 µg/m<sup>3</sup>)]. Conclusions: Preliminary results indicate that PM<sub>2.5</sub> concentrations evaluated with the ECM personal exposure monitor are in agreement with those obtained with standard gravimetric samplers and cyclone/impactors.

**P01.0470. Personal Sensors and In Situ Interviews to Assess Pollution Exposure in a Busy Intersection of Mexico City**

Yazmin Valdez-Torres

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Abstract: Personal sensors measuring CO and PM2.5 concentration levels were displayed to assess the most polluted areas in a busy intersection of Mexico City. Using Geographical Information System and proper statistical handling, exposure levels to traffic-related air pollution were localized in time and space. Concurrently, a questionnaire was applied in situ to detect respiratory disease symptoms in people that work or pass by the intersection. The methodology employed allowed comparison (in terms of pollution exposure) of pedestrian routes at street level, and long term daily exposure effects. Results found that 91 % of people who use the intersection as a workplace presented chronic respiratory diseases, and also high pollution emitters were identified. The study led to recommendations on emission vigilance, and reduction of pedestrian exposure by street layout design changes.

## **P01.0480. Using Arduino Air Sensors to Create STEM Interest in Under-Represented Populations**

Teresa Jarvis

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Abstract: Air pollution is a cause for concern on a global scale because of the continuing health impacts. The purpose of this study is to raise awareness of local air pollution, and incorporate STEM training to students in the Wissahickon School District, Pennsylvania. The negative effects include respiratory, cardiovascular, cardiopulmonary and reproductive systems, and even cancer. The effects of particulate matter exposure may be greater on children compared to adults, because of the children's rapid growth rate. In addition to particulate matter collection, this study also included the development of students to engineering, coding and data collection. Another component to this study was leadership development in under-represented STEM populations. Personal air sensors can be used to monitor short-term exposure using fixed-site monitoring (FSM). High school students used the Arduino air sensor to collect local data in Ambler, PA. These inexpensive air sensors were calibrated with research grade air quality monitors. The initial building team was comprised of students who are under-represented in the STEM fields. The head team built and problem-solved two initial models. This team then taught twenty other students of varying backgrounds to build the Arduino air sensors. Eighty-five high school students collected data using the sensors. The data was used to inform students about air pollution and raise their awareness of the impact of air pollution exposure. Implementing less expensive equipment would enable projects to occur in areas where data needs to be collected but the air sensors are considered too expensive.

**P01.0490. Merging Low-Cost and Conventional Air Monitoring Methods to Investigate Biomass Burning in a Highly Impacted, Multi-Cultural Rural Setting**

Orly Stampfer

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Abstract: The lower Yakima Valley of Washington State is a rural area home to communities including Latinx farmworker families, the Confederated Tribes and Bands of the Yakama Nation, and Native Americans of other tribes. Episodic poor air quality impacts this region, partly due to a mixture of different particulate matter (PM) sources, including residential wood smoke, agricultural biomass burning, and diesel emissions. We investigated air quality using low-cost and conventional approaches. University of Washington partnered with Yakama Nation Environmental Management Program and Heritage University to collect data at a tribal air monitoring site from 1/29/18-3/12/18 using a laser based, low-cost, 5-bin particle counter and a 5-wavelength aethalometer (MA200 Aethlabs). We used an established indicator for biomass burning and wood smoke: Delta-C, the difference in absorbance of the aethalometer at 375nm-880nm. We estimated an indicator for soot and aged diesel using the ratio of the mass at 375 vs. 880, where a ratio closer to 1 indicated more soot and aged diesel. A co-located tribal beta-attenuation monitor measured hourly PM<sub>2.5</sub> mass. Over 43 days, the daily PM<sub>2.5</sub> mean was 7.5 µg/m<sup>3</sup> (SD 4.7 µg/m<sup>3</sup>, range 1.3-20.7 µg/m<sup>3</sup>). Hourly Delta-C mean was 0.27 µg/m<sup>3</sup> (IQR 0.34 µg/m<sup>3</sup>). For 11 instances, the hourly ratio of Delta-C to PM<sub>2.5</sub> mean was >1/7.5, indicating episodes of high biomass burning. The hourly ratio of the mass at 375 vs. 880 mean was 1.5 (IQR 0.95). Nighttime mean PM<sub>2.5</sub> (8.8 µg/m<sup>3</sup>) and Delta-C (0.39 µg/m<sup>3</sup>) were greater than daytime PM<sub>2.5</sub> (5.9 µg/m<sup>3</sup>) and Delta-C (0.16 µg/m<sup>3</sup>). The mean ratio of Delta-C to PM<sub>2.5</sub> mass was greater at night (0.038) than daytime (0.027). Daytime correlations varied between Delta-C and PM<sub>1</sub> (0.33), PM<sub>2.5</sub> (0.28), and PM<sub>10</sub> (0.21) and nighttime correlations were all 0.79. This study shows a promising example of merging data from novel low-cost instruments with existing technology that can inform a community about their exposure to biomass burning.

## **P01.0500. Developing a Community-Engaged Low-Cost Air Monitoring Network in Seattle, Washington**

Nancy Carmona

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Abstract: The Community Air Monitoring in Puget Sound (CAMPS) network is being developed as part of a community-engaged research study to provide neighborhood level air quality data to groups that are concerned about air quality. The goal of this study is to collect and provide air quality data to residents in order to support individual and community actions to reduce exposures to improve their health. In addition to university academics, partners in the study include child care centers, community clubs, and youth clubs. Partners were recruited via email, phone, or in-person canvassing. Groups were invited to participate if they reside in Seattle, were near major highways or roadways, and were concerned about air quality. The community engagement framework of this study has opportunities for community partners to be an integral part the study design, including selecting monitoring sites, data collection, and report back process. A comprehensive needs assessment was completed through a community survey, key informant interviews, and discussions with community members and community steering committees. Findings on neighborhood differences will be presented from the ongoing monitoring network that uses 10 low-cost air monitors to measure real-time PM<sub>2.5</sub> (particulate matter with aerodynamic diameter <2.5 μm), nitrogen dioxide, carbon monoxide and ozone data. To encourage engagement, air monitoring data are shared with the public in the form of a real-time data website and monitoring reports. Evaluation at the conclusion of the study will be crucial in determining if the project goals are attained and in identifying improvements for future community-engaged air monitoring studies. Preliminary results in our monitoring network have found mean background PM<sub>2.5</sub> at 8.01 ug/m<sup>3</sup> and 13.47 ug/m<sup>3</sup> near roadways. This submission will present the results of the needs assessment, discuss motivating factors related to community participation in CAMPS, and summaries of CAMPS air monitoring.

## **P01.0510. A Mobile Health Approach to Improving Personal Exposure Assessment: Using Mobile Sensor Data and Machine Learning to Predict Key Microenvironments**

Hua Hao

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**Abstract:** Background: The assessment of personal exposure to air pollution is a critical component of environmental epidemiology, but the majority of current studies rely on diary-reported time-activity data which suffer from recall bias and do not accurately capture individuals' key microenvironments encountered in daily life. Recent advance in mobile sensing technologies combined with machine learning approaches have the potential to improve personal exposure assessment. Aims: To predict time-resolved activity in key microenvironments (indoor, outdoor and in transit) based on passively collected smartphone sensor data and evaluate the performance using machine learning algorithms. Methods: The Android application 'AndroSensor' was used to passively log 8 environmental sensors on a Samsung S4 smartphone every 10 seconds. Scripted activities were annotated over five days. Data was transformed and missing values imputed where possible. We considered the task of microenvironment prediction as a classification problem and compared the performance of a Random Forest (RF) algorithm to four other methods: K-nearest neighbors (KNN), multinomial logistic regression (MLR), Naïve Bayes (NB), and decision tree (DT). We used 10-fold cross-validation to evaluate prediction ability. Feature importance was calculated based on node impurity of the random forest. Results: We collected a total of 21,296 observations on 31 different features. The highest accuracy achieved was 98.61% for RF, followed by 95.65% for KNN, 89.48% for MLR, 85.01% for NB and 92.50% of DT. The following five features were consistently ranked as most important: sound level, speed, temperature, total satellites in range, and location accuracy. Conclusion: Our RF algorithm outperforms all the other 4 algorithms and achieves a high accuracy. Our developed model can be used to improve existing personal air pollution exposure assessment in conjunction with spatiotemporal estimates of ambient air pollution.

## **P01.0520. Estimation of Individual Based Exposure Assessment for Indoor Radon Using the Propensity Score Method**

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**Abstract:** Epidemiologic studies are the best way to examine the risk and association between residential radon exposure and lung cancer. Previous studies suggest that exposure to residential radon may contribute to the incidence of lung cancer in the general population and varying residential conditions could also affect the relationship of radon exposure and lung cancer. Many studies considering association were conducted worldwide, however few studies have shown the causal inference. To investigate the causal association between residential radon and lung cancer based on Korea living conditions, we conducted a study using propensity score method in Korea. This study includes data from 4 hospitals (Ajou university, Severance, Wonju severance, Seoul-asan) for the treatment group (Lung-cancer patients) and from 4 community-based cohorts (Seoul CMERC, Wonju KoGES, Ansung KoGES, Kyeongnam Namgaram) for the control group (Not lung-cancer patients). Total 440 (650 treatments and 5624 controls) were included in the data. Considering age, sex, smoking status, and socio-economic factors the propensity score was analyzed. The propensity score method we used was propensity score matching. The characteristic differences for covariates before and after propensity score matching is shown. Also, the distribution difference between raw data and matched data is represented in Figure 1. The propensity score distribution in the control group was matched to the treated group. The odds ratio for using propensity score matching and without propensity score were demonstrated in Figure 2. This study examined the causal association between indoor radon level and lung cancer in Korea. However, due to lack of data further study is needed after data completion.

## **P01.0540. Evaluating Association between Air Pollution and Cardiovascular Outcomes Using Smartphone Particle Sensors and Wearable Technologies in Children**

Chris Lim

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**Abstract:** Introduction: Recent development of both portable air pollution particle sensors and wearable technologies offers unique opportunities to study the real-time association between exposure and cardiopulmonary outcomes. We explored potential application of two technologies, AirBeam2 and Hexoskin smart shirt in a group of children. Methods: Elementary school aged children (N=12) in Albany, NY, are being equipped with particle sensor 'AirBeam2' (which measures PM1, PM2.5, and PM10), and a HexoSkin smart t-shirt (which measures heart rate, heart rate variability, breathing rate, ventilation) for a 1 week period, during all waking hours. Results: We will consider performance of AirBeam2 with stationary monitors, both a real-time instrument and integrated gravimetric filter system, previously placed within the classroom. The real-time relationship between exposure to PM and changes in heart rate variability, relative to baseline, will be measured and modeled using linear mixed models. We will also calculate lung deposited dose for PM using the measured lung function metrics from HexoSkin. Conclusion: Unique challenges were observed and experienced by researchers in this study assessing potential deployment of novel sensors in young children to study air pollution-health relationship. Preliminary results suggest that increased exposure to particulate matter exposure can potentially affect adversely cardiovascular outcomes among children.

## **P01.0550. Method Suggestion of Predicting the Exposure to Residential Indoor Air Pollutants Using Time-Activity Patterns and Outdoor Air**

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Abstract: Most people may be affected by indoor air quality at home since it is where they spend most of their time. Although air pollutants (APs) concentrations such as particulate matter, SO<sub>2</sub>, NO<sub>2</sub>, CO, and O<sub>3</sub> is provided through ambient fixed monitoring system, it could be different from actual exposure concentrations because it has limitations such as distance and staying in indoor environments. The purposes of this study were to predict the concentrations of Indoor APs (IAPs) and to assess exposures at home considering indoor sources and house residential time of people by analyzing time-activity patterns including questionnaire. To estimate IAPs concentrations, we applied the concentration of outdoor air pollutants by measurements or atmospheric modelling, and indoor air quality model to PM, NO<sub>2</sub>, CO concentrations with indoor sources, and Indoor/Outdoor ratio acquired from previous studies, and to SO<sub>2</sub> and O<sub>3</sub> concentrations without indoor sources. The concentrations of APs were acquired from ambient fixed monitoring system. And the concentrations of IAPs were measured in houses with sensor instruments of particulate matter by adjusting gravimetric method, and exposure to IAPs were estimated. Residential time at home was more than about 90% their times. Results of measurements of sensor indicate increased concentrations of IAPs with indoor sources from cooking, cleaning and smoking than usual (no behavior) and concentrations of IAPs with indoor sources increase as number of the behavior increase. Sub-populations such as the old and housewives might be more likely to be affected by house indoor air because they spend most of their time at home. We predicted the concentrations of IAPs and assessed exposures at home to IAPs by modelling and analyzing time-activity patterns including questionnaire. These results will be expected to provide basis for preparing guidelines for prevention of diseases caused by house IAPs

## **P01.0551. Towards Continuous Domain Models in Spatial Epidemiology**

Garyfallos Konstantinoudis

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Abstract: One of the goals of spatial epidemiology is to identify areas with elevated disease risk. Such analyses are often hampered by the limited geographical resolution of the available data. When data are aggregated into spatial units, conditional autoregressive (CAR) models are commonly used. When data are available at higher resolution (e.g. geocodes), log-Gaussian Cox processes (LGCPs) provide a more natural modelling framework. In theory, LGCPs should perform better, but do they? We simulated data mimicking childhood leukaemia incidence in the Canton of Zurich in Switzerland (n=334 during 1985-2015). Geocoded locations of residence were available for the entire population. We randomly sampled case locations from these data under different risk scenarios. We considered 39 scenarios varying the shape of the true risk function (constant, step-wise, exponential decay), size of the high-risk areas (1, 5 and 10 km radii), risk increase in the high-risk areas (2 and 5-fold) and the number of cases (n, 5n and 10n). We compared the ability of the models to recover the true risk surface using the root mean integrated squared error (RMISE) and their ability to identify high-risk areas using area under the ROC curve (AUC). CAR models recovered the step-wise true risk surface with lower error across all scenarios (range of median RMISE across scenarios: 0.05-0.25) compared to LGCPs (median RMISE: 1.80-37.2). For exponential decay risk surfaces, however, LGCPs performed better (median RMISE: 1.70-20) compared to CAR (median RMISE: 1.80-32) in almost all scenarios. The ability to detect high-risk areas was higher for LGCPs (median AUC: 0.81-1) compared to the CAR model (median AUC: 0.65-0.93) across almost all scenarios. Our simulation study suggests that, under realistic scenarios, continuous domain models outperform discrete domain models in estimating risk surfaces and identifying high-risk areas. This argues for moving towards continuous domain models in spatial epidemiology.

**P01.0552. Temporal Trend of Exposures to Polycyclic Aromatic Hydrocarbons and Bisphenol A during 2012-2016: A Comparison between China and the United States**

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**Abstract:** At national scales, changes in human exposures to environmental chemicals are largely driven by government's regulatory actions. Due to the inter-country variations in social, cultural, and economic conditions, the temporal trends of human exposures to chemicals are likely to be different among countries. To test this hypothesis, urine samples (n=350) were collected from four panels of summer exchange students (n=45) between University of California, Los Angeles (UCLA, in Los Angeles, United States) and Peking University (in Beijing, China) in 2012, 2014, 2015, and 2016. The urinary metabolites of two groups of environmental pollutants, namely polycyclic aromatic hydrocarbons (PAHs) and bisphenol A (BPA) were measured. In each year, exposures to PAHs and BPA were both significantly higher in Beijing than in Los Angeles ( $p < 0.05$ ). From 2012 to 2016, PAHs exposures didn't change in Los Angeles, but continuously decreased in Beijing ( $p < 0.01$ ) which was probably due to the drastic reduction in PAHs emissions from residential, commercial, and industrial sources in China. BPA exposures, by contrast, continuously decreased in Los Angeles ( $p < 0.001$ ), but didn't change in Beijing. This is likely due to extensive efforts from government and manufacturers to phase out BPA in the United States and calls for actions to regulate BPA in China. Overall, the observed temporal trends of PAHs and BPA exposures reflect the difference in pollution controlling measures between the two countries.

## P01. Air Pollution 1

### **P01.0560. Perinatal Exposure to Ambient Air Pollution and Greenness, and the Incidence of Paediatric Diabetes: A Population-Based Cohort Study**

Michael Elten

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**Abstract:** Background: Ambient air pollution exposure during early life has recently been associated with diabetes incidence in children. However, little is known regarding critical exposure windows and if exposure to greenness could modify these associations. This study sought to assess the relationship between selected air pollutants (NO<sub>2</sub>, PM<sub>2.5</sub>, O<sub>3</sub>, and Ox [oxidant capacity]) and the incidence of paediatric diabetes. Methods: Our cohort consisted of 754,698 mother-infant pairs occurring between 2006 and 2012 in the province of Ontario, Canada. Diabetes incidence was ascertained using population-based health administrative data with a validated algorithm. The cohort was followed until 2015. Temporally adjusted exposure to NO<sub>2</sub>, PM<sub>2.5</sub>, and O<sub>3</sub> was estimated using satellite-based regression, land-use regression, and a fusion-based approach, respectively, and was assigned to subjects' residential postal codes during pregnancy. Ox was calculated as the redox-weighted average of O<sub>3</sub> and NO<sub>2</sub>. Satellite-derived normalized difference vegetation index (NDVI) was used to represent the amount of green vegetation at a 250m buffer across Ontario. Associations between total pregnancy, trimester specific, and early life exposures to ambient air pollutants and childhood diabetes incidence up to age 6 were estimated using Cox regression models.

**Results:** 1,094 children with diabetes were identified. Each IQR increase in O<sub>3</sub> and Ox exposures in the second trimester of pregnancy were associated with hazard ratios of 1.36 (95% CI: 1.07-1.73) and 1.45 (95% CI: 1.05-1.81), respectively. These relationships exhibited linear shapes, and exposure to greenness was found to have a protective modifying effect (p-interaction ≤ 0.04). There were no other positive associations observed for other pollutants and other time periods.

**Conclusions:** Air pollution, especially O<sub>3</sub> and Ox, was linked to increased diabetes risk in children. Exposure to greenness during pregnancy appeared to attenuate these associations.

**P01.0570. Pervasive Developmental Disorder and Particulate Matter Air Pollution before, during and after Pregnancy: A Case-Cohort Study within the National Infant Medical Check-Up Cohort**

Jueun Lee

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**Abstract:** Background: There is increasing interest in the effect of air pollution in children's neurodevelopment but the evidence remains inconclusive. This study investigated the association of particulate matter air pollution exposure and pervasive developmental disorder (PDD) throughout the first 6 years of life. Methods: We conducted a case-cohort study of participants born in Korea in the year of 2008 who underwent at least the first medical check-up provided by The National Health Insurance Database until December 31, 2013. The study assessed all 761 subjects who were diagnosed with PDD till the age of six along with a subcohort of six times of that size, 5,178 subjects, selected as a 2.5% random sample of the full target cohort. Diagnosis of PDD was based on the payment and treatment data at the clinic. Daily averages of PM with diameters  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) and  $\leq 10 \mu\text{m}$  (PM<sub>10</sub>) were predicted from a spatiotemporal model for South Korea and linked to residential addresses. A weighted Cox proportional hazards model was used to estimate adjusted hazard ratio (aHR) with 95% confidence intervals (CI) for PDD in infants exposed to particulate matter air pollution. Results: A significant association was found between 10  $\mu\text{g}/\text{m}^3$  increment in the PM<sub>2.5</sub> concentration and PDD with adjusted RR of 1.12 (95% CI 1.04-1.20) among the participants with the same address before and after pregnancy. Associations with PM<sub>2.5</sub> exposure 9 months before or after the pregnancy were weaker in independent models and when all periods were included, whereas the association with the 9 months of pregnancy remained. The association between PDD and PM<sub>2.5</sub> was stronger for exposure during the third trimester (OR = 1.32 per IQR increase in PM<sub>2.5</sub>; 95% CI: 1.16, 1.49) than during the first two. There was little association between PM<sub>10</sub> and PDD. Conclusions: The results suggest higher maternal exposure to PM<sub>2.5</sub> during pregnancy, particularly the third trimester, was associated with the risk of developing PDD.

**P01.0580. Fine Particle (PM2.5) and Preterm Birth from 7 Metropolitan Cities Study, Korea, 2015-2016**

Eun-Hee Ha

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**Abstract:** Particulate matter contributing to low birth weight and preterm birth are of great concern because of the well-known relation of birth weight to infant mortality and adverse effects in later life. We examined the associations between fine particle (PM2.5) during the pregnancy and low birth weight and preterm birth for a 2-year period (January 2015 to December 2016) in 7 metropolitan cities, Republic of Korea. We obtained birth certificates in the 7 metropolitan cities from the Korean National Birth. The associations were evaluated with a logistic regression adjusting for gestational age, maternal age, parity, birth month, and infant sex. We determined the first and third trimester (TR) periods and ascertained birth weight and most of the covariates included in this study. PM2.5 data were obtained from the Ministry of Environment. Of 406,243 births registered, we included 176,842 births which are in 7 metropolitan cities, 22-42 weeks, and 500-5000g in the final analysis. When we consider first TR and third TR period, respectively, the risk of pre-term (gestational age < 37 weeks) by 10 µg/m<sup>3</sup> increase PM2.5 concentrations for first TR period was 1.066 (95% CI: 1.029-1.104) and for third TR period was 0.992 (95% CI: 0.953-1.034). However, we consider first TR and third TR period, the risk of pre-term (gestational age < 37 weeks) by 10 µg/m<sup>3</sup> increase PM2.5 concentrations for first TR period was and for third TR period was 0.983 (95% CI: 0.943-1.025). When we entered concentrations of PM2.5 during the first and third TR of pregnancy together in the model, the relative risk of low birth weight for PM2.5 during the first TR of pregnancy remained constant (OR: 1.058, 95% CI: 1.020-1.097). However, in the third TR, the risks changed toward the null for all pollutants (OR: 0.983, 95% CI: 0.943-1.025). PM2.5 concentrations in the first TR of pregnancy period are risk factors for preterm birth. **Keywords :** PM2.5., low birth weight, preterm birth, 7 metropolitan cities, Korea

**P01.0581. Indoor Air Pollution and Reduced Lung Function in Biomass Exposed Women:  
A Cross Sectional Study in Pune District, India**

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Abstract: Indoor air pollution especially from the use of biomass fuels, remains a potentially large global health threat. The inefficient use of such fuels in poorly ventilated conditions results in high levels of indoor air pollution, most seriously affecting women and young children. The main aim of this study was to measure and compare the lung function of the women exposed in the biomass fuels and LPG fuels and relate it to the indoor emission measured using a structured questionnaire, spirometer and filter based low volume samplers respectively. This cross-sectional comparative study was conducted among the women (aged > 18 years) living in rural villages of Pune district who were not diagnosed of chronic pulmonary diseases or any other respiratory diseases and using biomass fuels or LPG for cooking for a minimum period of 5 years or more. Data collection was done from April to June 2017 in dry season. Spirometer was performed using the portable spirometer to determine the lung function over Forced expiratory volume. The primary outcome variable was forced expiratory volume in 1 second (FEV1). Secondary outcome was chronic obstruction pulmonary disease (post bronchodilator FEV1/ Forced Vital Capacity (FVC) < 70%) as defined by the Global Initiative for Obstructive Lung Disease. Potential confounders such as age, height, weight, smoking history, occupation, educational status were considered. Preliminary results showed that the lung function of the women using Biomass fuels had comparatively reduced lung function than the LPG users . The mean PM 2.5 mass concentration in the biomass user's kitchen was higher than in the LPG user's kitchen. Black carbon amount was found higher in the biomass users than LPG users . Therefore, there is an urgent need to adopt various strategies to improve indoor air quality.

## **P01.0582. Indoor Nitrogen Dioxide in Homes with Biomass Cookstoves before and after a Gas Stove Intervention**

Josiah Kephart

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**Abstract:** Emissions from biomass-fueled cookstoves are the largest environmental contribution to the global burden of disease, responsible for 2.6 million deaths annually. A transition from biomass to liquified-petroleum gas (LPG) cookstoves has been proposed as a global public health intervention. While this transition seems likely to reduce fine particulate matter and carbon monoxide, very little is known about cookstove-related emissions of nitrogen dioxide (NO<sub>2</sub>), a threat to respiratory health. Assessing exposure to NO<sub>2</sub> from biomass and LPG cookstoves is essential to understand the public health risks posed by biomass cookstoves and inform the current promotion of LPG as a healthier alternative to biomass fuel. This study aims to 1) quantify NO<sub>2</sub> exposure from biomass cookstoves and 2) assess changes in NO<sub>2</sub> exposure after the transition from biomass to LPG cookstoves. We will measure NO<sub>2</sub> concentrations in 100 kitchens with biomass cookstoves in rural Puno, Peru. Concentrations will be sampled by direct-reading instruments at one-minute intervals for 48 hours, allowing us to quantify both daily mean concentrations and short-term concentration peaks associated with cooking events. To assess the effect of transitioning from biomass to LPG on kitchen NO<sub>2</sub> concentrations, we will randomize 50 of these households to receive free LPG stoves and fuel and 50 households to serve as a control. We will measure NO<sub>2</sub> concentrations three months post-intervention. In our study setting, homes with biomass cookstoves experienced daily NO<sub>2</sub> concentrations [48-hour mean (sd): 139 ppb (92), n=99] well above the WHO indoor annual guideline (21 ppb). Acute exposures were also elevated, as 26% of kitchen-hours [1-hour mean (sd): 139 ppb (252), n=2376 hours] were above the WHO indoor hourly guideline (105 ppb). Transitioning from biomass to LPG cookstoves reduced daily NO<sub>2</sub> concentrations by 40%, however these concentrations [mean (sd): 73 ppb (47), n=40] remain above the WHO annual guideline (21 ppb).

**P01.0583. Association between Air Pollution Exposure and Inflammation in Chronic Obstructive Pulmonary Disease Patients in Beijing, China**

Yuan Yao

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**Abstract:** Background/Aim: Chronic obstructive pulmonary disease (COPD), characterized by chronic inflammation, is one of the leading causes of death worldwide. The biological mechanism of inflammation associated with exposure to air pollution in COPD patients are not well understood. To elucidate the association between air pollution exposure and inflammatory response in COPD patients, 135 subjects, including 53 stable COPD patients and 82 healthy controls, were recruited in a panel study in Beijing, China. Methods: Fractional exhaled nitric oxide (FeNO) and serum cytokines were repeatedly measured from each subject during 4 visits. Levels of air pollutants, including mass and number concentration of fine particulate matter, mass concentration of black carbon/organic carbon (OC)/elemental carbon/ heavy metals, gaseous pollutants, were online monitored. Linear mixed-effect models were used to estimate the different inflammatory responses to the air pollution exposure between COPD patients and healthy controls. Results: Exposures to SO<sub>2</sub>, OC and ultrafine particles (UFP) were positively associated with the levels of FeNO, which were more significant in COPD patients. Increases in levels of IL-6 associated with CO, Mn and Cu exposures in COPD patients were significantly higher than those in healthy controls. Exposures to UFP and Acc were associated with increasing levels of IL-15, which were more significant in COPD patients. Exposure to CO was associated with decreasing levels of IL-1 $\beta$ , IL-4, IL-10, IL-13 and IL-17A in healthy controls, which was not observed in COPD patients. Conclusions: In summary, COPD patients are susceptible to the acute respiratory inflammation associated with air pollution exposure, and their capabilities to regulate inflammation are weaker than healthy controls. Acknowledgement: The study was funded by National Program on Key Basic Research Project (2015CB553401). We thank all the volunteers, students and staff involved in COPD for their contributions.

## **P01.0584. Leveraging Real-Time Data to Identify Determinants of Indoor PM2.5 Exposure Disparities at the Community-Level**

MyDzung Chu

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**Abstract:** Elucidating determinants of increased indoor exposures is critical to alleviating exposure and health disparities. PM2.5 is a key determinant of indoor air quality and cardiorespiratory health. As part of the Center for Research on Environmental & Social Stressors in Housing across the Life Course (CRESSH), we investigated indoor PM2.5 sources within small spatial and temporal scales. We recruited 72 households in Chelsea, MA from 6/2016-8/2017. We collected in-home and outdoor PM2.5, housing, and activity data across 1 week for 2 seasons using a real-time sensor platform, visual assessments, and surveys. We assessed predictors of indoor PM2.5 by season using linear mixed-effect models accounting for non-linear effects of time and outdoor PM2.5, race/ethnicity, rent status, housing type, occupancy, and kitchen vent use. Households were predominantly Hispanic/Latino (49%), renters (54%), & low-income (<\$50K) (54%). Mean indoor PM2.5 was 10.3 $\mu\text{g}/\text{m}^3$  (SD: 60.2) for summer and 9.6 $\mu\text{g}/\text{m}^3$  (30.2) for winter. Across seasons, significant predictors were time of day ( $\beta=1.16-2.18$ ,  $p<0.01$ ) & outdoor PM2.5, which was more strongly associated in summer ( $\beta\geq 1.43$ ,  $p<0.02$ ). In summer, use of gas stoves (vs. electric) ( $\beta=2.05$ ) & having visitors who smoked ( $\beta=4.55$ ) were also significant ( $p<0.04$ ). In winter, any weekend cooking ( $\beta\geq 3.23$ ), residential smoking ( $\beta=2.72$ ), & weekday status ( $\beta=1.07$ ) were also significant ( $p<0.02$ ). Risk factors varied socio-demographically: renters were more likely to smoke (8.5x), homeowners more often had gas stoves (1.3x), & low-income households cooked longer periods ( $\geq 60$  min.: 1.72x). Our findings underscore the value of real-time data to identify time-varying sources and contributors of indoor PM2.5. Seasonal effects are likely driven by changes in meteorology, housing conditions, and activity that affect air exchange. The socioeconomic patterning of risk factors, much of which is modifiable, implicate targets for reducing exposure and health disparities.

## **P01.0585. Developing Advanced PM2.5 Exposure Models in Lima, Peru**

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**Abstract:** Background: There is convincing evidence of adverse health effects induced by exposure to PM2.5 in the growing body of literature. Lima's topography and aging vehicular fleet results in severe air pollution with limited amounts of monitors to effectively quantify measurements for epidemiologic studies. Objectives: We propose to develop a high-performance satellite-driving exposure model to estimate daily PM2.5 concentrations at a 1 km spatial resolution in Lima, Peru from 2010 to 2016 using a combination of ground measurements, aerosol optical depth (AOD), meteorological fields, parameters from atmospheric chemical transport models, and land use variables. Methods: Parameters from the Weather Research and Forecasting model coupled with Chemistry (WRF-CHEM) and the European Centre for Medium-Range Weather Forecasts (ECMWF) were evaluated against ground monitoring stations from Weather Underground. A random forest model was used to gap-fill non-random missing satellite AOD data due to cloud cover to enhance spatial coverage and quality. Both a linear mixed effects model and a random forest model was used to fit AOD, WRF-CHEM, ECMWF, meteorological fields, and land use parameters against ground measurements from 16 monitoring stations with available data between 2014 to 2016. Both models were then used to estimate daily PM2.5 concentrations from 2010 to 2016. Results: The overall cross-validation (CV) R2 value and (RMSE) for the linear mixed effects model and random forest model was 0.58 (7.08 µg/m3) and 0.73 (5.66 µg/m3), respectively. The random forest model's robust ability to include more parameters outperformed the linear mixed effects model due to limited number of ground observations. Conclusions: Our models allow for construction of long-term historical daily PM2.5 levels to support fundamental and imperative epidemiological studies that will likely impact governmental policies on air quality in Lima, Peru.

## **P01.0590. Metabolic Syndrome and Its Mediation Effects of Fine Particulate Matter and Cardiovascular Disease**

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**Abstract:** Background / Aims Considerable epidemiological evidence indicates particulate matter (PM) as a major risk factor for cardiovascular diseases (CVD). Also, Metabolic syndrome (MetS) is well known as an important risk factor for CVD and a few studies show epidemiological association between PM and MetS. However, a study on the effect of PM on CVD as a mediator of MetS is still scarce. Thus, we examined a mediation of the association between PM<sub>2.5</sub> and CVD by MetS. Methods / Results Participants of this study were 153,417 adults from the national health screening cohort provided by Korea National Health Insurance who had health examination from 2009 to 2015. MetS was defined by National Cholesterol Education Program the third Adult Treatment Panel and exposure to PM<sub>2.5</sub>, one-year average before CVD diagnostic, was assessed using a Community Multiscale Air Quality (CMAQ) model. To determine whether MetS is a mediator variable and to quantify the mediation effect, we conduct a counterfactual mediation analyses. The effect estimates (natural direct effect (NDE), natural indirect effect (NIE), and total effect) with 1- increase in one-year average PM<sub>2.5</sub> concentration and the percentage of the effect of mediator were calculated by logistic regression models. Also, 95% confidence interval (CI) were obtained from bootstrap method. Results from adjusted mediation analyses showed that the mediation was significant for the association between PM<sub>2.5</sub> and CVD (NIE: 1.001, 95% CI: 1.000 - 1.002). In addition, the percent of the total effect mediated by MetS was 13% (p-value: 0.04), in reference to a total adjusted odds ratio of 1.010 (95% CI: 1.005 - 1.013). Conclusion Our findings suggest that MetS might appear as a mediate on the association between PM<sub>2.5</sub> and CVD. These results highlight the need of a further study to clarify that exposure to one-year average PM<sub>2.5</sub> is associated with an increased risk of CVD mediated by MetS.

**P01.0600. Shale Gas Development, Natural Gas Flaring, and Pediatric Asthma Hospitalizations from 2000 to 2010 in Texas, U.S.A.**

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**Abstract:** Background: Current estimates indicate that 4.5 million Texans live within 1 mile of at least one shale gas development (SGD) site, yet the respiratory health effects of residing near this industry remain unclear. SGD activities are associated with decreased air quality, including known respiratory irritants. This study aims to quantify the association between specific SGD activities and pediatric asthma hospitalizations in Texas. Methods: We leverage a 32 million record database of Texas inpatient hospitalizations to examine the association between natural gas development and pediatric respiratory hospitalizations via multilevel logistic models. In contrast to previous studies, we implement a quasi-experimental design to account for pre-existing spatiotemporal asthma hospitalization trends. We then use a database of monthly production reports to assess the heterogeneity of impact from drilling-specific exposures including drilling type and gas flaring activities. Results: We find that any drilling yields odds ratios ranging from 1.13 (95% CI: 0.99, 1.30) to 1.86 (95% CI: 1.57, 2.22) depending on age groups. Our results demonstrate that conventional drilling (OR: 2.02; 95% CI: 1.69, 2.41) may yield a higher risk for pediatric asthma hospitalizations than unconventional drilling (OR: 1.63; 95% CI: 1.33, 2.00). Additionally, flaring activities are consistently associated with pediatric asthma hospitalizations across multiple age groups, ranging from 1.09 (95% CI: 0.96, 1.22) to 1.54 (95% CI: 1.32, 1.78). These results hold across multiple sensitivity analyses. Conclusion: Pediatric asthma hospitalizations are increased with SGD and are similarly affected by conventional and unconventional drilling. Flaring may be a potential pathway for this association.

## **P01.0620. Comparison of Prediction Algorithms for Modelling Air Pollution Surfaces**

Jules Kerckhoffs

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Abstract: Land use Regression (LUR) models for air pollutants have often been developed using linear regression techniques. More recently, other multivariable methods have been used varying from penalized regression techniques, to variable selection methods and machine learning algorithms. These algorithms may have statistical advantages over linear (stepwise) regression techniques as they may account better for correlated structures and more flexible relationships, for example. However, empirical comparisons between different multivariable algorithms have been limited. We compared several prediction algorithms that have been used previously to create spatial air pollution surfaces including stepwise (penalized) regressions, Deletion/Substitution/Addition (DSA) algorithm, general additive models (GAM), neural networks, and random forests. We used two training sets of ultrafine particle (UFP) data; one based on mobile measurements (8200 segments, 25 seconds monitoring per segment), the other based on short-term stationary measurements (368 sites, 3x30 minutes per site). We evaluated different modelling approaches by comparing predictions to external long-term average UFP concentrations. Models that allow flexible relationships and machine learning approaches tended to describe the training data better than multiple regression techniques, both for the mobile data and short-term data (best R<sup>2</sup> for machine learning is 0.29 vs R<sup>2</sup> range of 0.12-0.15 for multiple regression). However, high training model R<sup>2</sup> did not equate to high R<sup>2</sup> for the external long-term average concentrations, especially for machine learning algorithms trained on mobile measurements. Machine learning algorithms explained only 38-47% of external UFP concentrations whereas multivariable methods like linear stepwise regression, DSA and GAM were able to explain 56-62%. These results indicate that multivariable methods might be preferred methods for LUR-modeling based on theoretical and empirical grounds.

## **P01.0630. Estimation of Historic PM2.5 Concentrations Using the PM2.5-PM10 Ratio in Mexico City and Metropolitan Area**

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**Abstract:** The Air Quality Monitoring System is the main source of particulate matter data in the Mexico City (MC) and Metropolitan Area (MA). The monitoring system's gradual development has produced variable coverage data throughout space and time, making difficult to use it for epidemiological studies. The WHO suggests to use the PM2.5-PM10 ratio (PMR) for PM2.5 estimation when only PM10 data is available. The aim was to estimate PM2.5 concentrations in the MC and MA using the PMR for 2003 to 2016, in order to increase space-time coverage data for epidemiological studies. The monitoring stations (MS) that measured simultaneously PM2.5 and PM10 were identified year by year. For each, the hourly PMR were estimated. Then, monthly and annual hourly PMR average were obtained. The hourly PM2.5 missing values in this MS were imputed by dividing the PM10 hourly data available between the annual hourly PMR average. In the MS that measured only PM10, PM2.5 monthly data was imputed using the monthly PMR average considering the location of the MS. The PM2.5 annual averages for each MS, for MC and MA were estimated. Pearson's correlation analysis and statistical significance tests were carried out between imputed and measured data. Procedures were done using R 3.4.1. and Stata 14. Higher annual hourly PMR average was observed in MC than in MA (54 vs 50%,  $p < 0.000$ ), and similar to the PMR suggested by the WHO (50%). PM2.5 was estimated for 101 MS which measured PM10 only, and for 5 MS which measured both. High concordance was observed between hourly data measured vs estimated for MS located in MC ( $R^2=0.83$ ) and in MA ( $R^2=0.73$ ). Most PM2.5 annual averages were no statistically different (data imputed included vs only measured data). Our results show that the PMR is an adequate method to robustly estimate space-time PM2.5 when only PM10 data is available. This study establishes a precedent for other urban areas where monitoring systems are growing and information of PM2.5 might not be available.

**P01.0640. Ozone and Emergency Department Visit for Asthma in the Seven Metropolitan Cities in Korea 2013-2015: A Case-Crossover Study**

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Abstract: Harmful effects of exposure to ground-level ozone on exacerbation of existing respiratory condition are supported by number of studies in various countries. The objective of this study was to determine the association between ozone and emergency department (ED) visits for asthma in seven metropolitan cities (Seoul, Busan, Incheon, Daegu, Gwangju, Daejeon, and Ulsan) in Korea. Emergency department visit records by asthma (ICD10: J45 or J46) were obtained from National Emergency Department Information System for the period of 2013 to 2015. Air pollutants and meteorological data were obtained from the National Institute of Environmental Research and the Meteorological Administration. A time-stratified case-crossover design was used to analyze relationship between ozone and ED visits by asthma. Pooled estimates across the seven cities were calculated using a fixed-effect model. In total, 21,259 ED visits were included. Mean ambient concentrations of ozone were ranged from 34.98ppb for Seoul to 41.84ppb for Gwangju. Estimated odds ratios (ORs) of ozone on ED visit by asthma with an increment of 10ppb were ranged from 1.061 (95%CI: 1.032-1.091) for Seoul to 1.323 (95%CI: 1.146-1.527) for Ulsan with 3-days lag period. The stronger associations were found in younger population (age<19) and estimated ORs were ranged from 1.088(1.099-1.173) in Incheon to 1.602(1.280-2.005). Estimated pooled OR estimates were 1.073(95%CI: 1.052-1.095) for the total population, 1.129(95%CI: 1.091-1.168) for younger population (age<19), 1.060(95%CI: 1.028-1.093) for adult population (19<=age<65), and 1.021(95%CI: 0.980-1.063) for elderly population (age>=65). This study results provide the evidence that short-term exposure to ozone increases ED visit by asthma, especially for younger population.

## **P01.0650. Modeling Transport of Windblown Soil Using HYSPLIT**

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Abstract: Dust from soils originating in drylands of the Great Basin (located in California, Idaho, Nevada, and Utah), can travel thousands of kilometers from the source through atmospheric transport, carrying particulate matter (PM), pollutants, and allergens. Dust, specifically PM less than or equal to 2.5 $\mu$ m (PM<sub>2.5</sub>), negatively affects health, increasing the risk of respiratory disorders, cardiovascular disorders, and skin irritation. The Utah Department of Environmental Quality (DEQ) collects 24-hour samples within Salt Lake City, Utah of PM<sub>2.5</sub> every three to nine days, which are analyzed for elemental composition. This data will be coupled with the National Oceanic and Atmospheric Administration Air Resources Laboratory Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT), a modeling system that creates air parcel trajectories. HYSPLIT can model backwards trajectories to track past atmospheric movement. By combining these two resources, this study will be able to assign days into clusters by PM composition and assess the backwards trajectories of air parcels to determine the possible origins of the PM clusters. Malm et al., through the Interagency Monitoring of Protected Visual Environments study, identified the chemical composition of soil from "fine aerosol species." This was done by summing elements associated with soils with a correction factor for the oxides:  $[SOIL] = 2.20[Al] + 2.49[Si] + 1.63[Ca] + 2.42[Fe] + 1.94[Ti]$  The DEQ dataset was used to calculate [SOIL] using the elemental components. Days with high concentrations have been selected for analysis with HYSPLIT. We will utilize the backward trajectory models within HYSPLIT to assess where the samples containing [SOIL] originated. It is predicted that this method will identify areas with specific soil element fingerprints, which may help to designate resources for remediation if necessary as well as improving exposure assessment for public health studies.

## **P01.0660. Outdoor Air Pollution Exposure and Lung Cancer Incidence in Korea: A Nationwide Population-Based Cohort Study**

Garam Byun

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**Abstract:** Background/Aim: The International Agency for Research on Cancer (IARC) has concluded that exposure to outdoor air pollution causes lung cancer. Epidemiological studies on air pollution associated with lung cancer played a crucial role in their decision. However, most of the epidemiological evidence is limited to western countries. We aimed to investigate the association between long-term exposure to outdoor air pollutants and lung cancer incidence in Korea. Methods: National Sample Cohort data from 2002 to 2013 were obtained from National Health Insurance Service in Korea. The study population included a total of 28,090 subjects without pre-existing cancer at baseline. The district level annual-average concentration of particulate matter with a diameter  $\leq 10$   $\mu$ m (PM<sub>10</sub>), nitrogen dioxide (NO<sub>2</sub>), and ozone (O<sub>3</sub>) were assigned to each individual based on residential address which is updated annually. Cox-proportional hazard regression model was used to estimate the effects of long-term exposure to air pollution on the incidence of lung cancer. Different exposure matrices and lag years were considered. Results: During 263,178 person-years, 160 incident cases of lung cancer were observed. Increasing yearly mean exposure in 10 ppb O<sub>3</sub> was associated incident lung cancer (hazard ratio [HR]: 1.61, 95% CI: 1.07-2.41). The results showed no association between lung cancer and PM<sub>10</sub> (HR: 0.91, 95% CI: 0.72-1.15) or NO<sub>2</sub> (HR: 0.84, 95% CI: 0.63-1.10). Each follow-up period average exposure and average cumulative exposure to O<sub>3</sub> before censoring were also marginally associated with lung cancer. Conclusion: Lung cancer incidence was most strongly associated with long-term O<sub>3</sub> exposure in this Korean study. Further investigation is required to provide strong evidence, however, our study suggests that annual guideline for O<sub>3</sub> is recommended in Korea.

**P01.0670. Estimating Exposure to Ultrafine Particles in the Greater Montreal Area among Case-Control Study Subjects: Comparison of Classical Land Use Regression Model with a Model Based on Bayesian Principles.**

Shilpa Karumanchi

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**Abstract:** Background: Despite currently inconclusive results there is evidence accumulating that ultrafine particles (UFP), a major portion of the particulate matter of air pollution, may play a role in the development of lung cancer. Ultrafine particles (UFPs), the finest particulate matter in air, vary with space and time which is a challenge in estimating levels of exposure for individuals in health studies. Therefore, we aim to evaluate robustness of two statistical regression models in estimating the levels of ultrafine particles in atmospheric air for Greater Montreal area. Methods: A fixed site monitoring campaign was designed to measure the levels of ultrafine particles with a dense monitoring network of 250 sampling sites in the Greater Montreal Area. Ultrafine particles were measured for 20 minutes at each sampling site. In order to derive average annual levels, three repetitions were performed in winter and three in summer. However, high spatio-temporal variation of UFP makes it difficult to fit a regression model with high predictive value. In this analysis, we attempt to derive regression model for UFP within a Bayesian framework by considering the unobserved latent effect and euclidean distance between the sampling points. The proposed model attempts to capture the dependency of ultrafine particles between the sampling points that are close to each other. Results: The efficiency of conventional land use regression models in predicting UFP levels will be compared with spatiotemporal modelling in Bayesian framework with non-stationary covariance. Regression models will be developed using 90% of the sampling points. The remaining 10% will be used to evaluate the robustness of the models in estimating the UFP levels. Conclusions/Next steps: The best model for estimating the UFP levels will be used to derive an exposure surface for the Montreal area. This will be used to evaluate risk within a case-control study of lung cancer conducted in Montreal.

**P01.0690. Effects of Long-Term Exposure to Ambient Air Particles on Cause-Specific Mortality and Life Expectancy in Seoul, Korea**

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**Abstract:** Background In South Korea, studies on the long-term effects of particulate matter with a diameter less than 10  $\mu\text{m}$  (PM10) are still limited. This study examined the effects of long-term exposure to PM10 on cause-specific mortality and life expectancy in Seoul, Korea. Methods Age-standardized mortality rates, life expectancy, and average annual levels of PM10 were computed for each 25 district in Seoul from 2004 to 2012. We used poisson regression to estimate the association between PM10 and cause-specific mortality and linear regression for life expectancy. The models were adjusted for area-level of socioeconomic status, smoking, health budget per capita, neighborhood safety, and green space using the Normalized Difference Vegetation Index (NDVI). Results Annual increase of 10  $\mu\text{g}/\text{m}^3$  in the concentration of PM10 was associated with increased all-cause, chronic lower respiratory disease, ischaemic heart disease, and hypertension mortality risk of 5.7% (95% CI: 4.4, 7.0%), 13.8% (95% CI: 9.2, 18.4%), 16.2% (95% CI: 12.0, 20.4%), 17.5% (95% CI: 8.7, 27%), respectively. Stratified analysis by sex showed that increase in mortality risk was higher for women. Effects of PM10 on cardiovascular mortality were higher in the districts with safer neighborhood environment. In the life expectancy analysis, annual 10  $\mu\text{g}/\text{m}^3$  increase in PM10 resulted in loss of life in 0.32 years (95% CI: -0.24, -0.40). Conclusions Long-term exposure to PM10 was associated with increased in cause-specific mortality and decreased life expectancy in Seoul, Korea.

**P01.0700. A Panel Study of Acute Cardiovascular Health Effects in Relation to Exposure to Traffic-Related Air Pollutants and Noise in Toronto, Canada**

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**Abstract:** Introduction: Air pollution is a known risk factor for death from heart disease. Urban populations are exposed to air pollutants (APs) and varying levels of noise in high-traffic environments. Acute, physiologic responses of the cardiovascular system may be important mechanisms by which these stressors trigger cardiovascular events. Methods: In 2016, we carried out a panel study of APs and noise in 46 adults who were non-smokers with no prior cardiovascular morbidity in Toronto, Canada. Personal (PM<sub>0.1</sub>, BC) and regional (PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>) measures of APs and noise were collected and oxidant capacity (Ox) was estimated from NO<sub>2</sub> and O<sub>3</sub>. We used linear mixed models with random subject intercepts to estimate associations between 8-hour average pollutant exposures and baseline-to-follow-up changes in endothelial function (RHI), blood pressure and heart rate, adjusted for temperature and 24-hour alcohol/caffeine intake. Results: Each IQR increase in regional PM<sub>2.5</sub> (5.5 µg/m<sup>3</sup>), O<sub>3</sub> (12.2 ppb) and Ox (7.4 ppb) exposure was associated with a decrease in RHI ( $\beta = -0.45$  95% CI -0.81- -0.09,  $\beta = -0.29$  95% CI -0.56- -0.02,  $\beta = -0.31$  95% CI -0.56- -0.06, respectively). Endothelial function worsened further among subjects with a BMI of  $\geq 25$  kg/m<sup>2</sup> with exposure to O<sub>3</sub> ( $\beta = -1.34$  95% CI -1.76- -0.92) and Ox ( $\beta = -1.26$  95% CI -1.71- -0.80). Each IQR increase in PM<sub>0.1</sub> (14,934 particles/cm<sup>3</sup>) was associated with a 2.5 beats/min higher heart rate among women (95% CI 0.74-4.27) and not men (p-interaction <0.05). No deleterious associations with continuous exposure to noise were found. BC exposure (1,163.8 ng/m<sup>3</sup>) was associated with an increase in heart rate among those exposed to noise levels above the median (67 dBA) ( $\beta = 2.61$ , 95% CI 0.02-5.19). Conclusion: Persons with BMI of  $\geq 25$  kg/m<sup>2</sup> were more susceptible to worsened endothelial function with exposure to O<sub>3</sub> and Ox, while women had increased heart rate with exposure to PM<sub>0.1</sub>. Higher levels of noise may impact associations of APs with heart rate.

## **P01.0710. Residential Proximity to Roadways and Placenta-Associated Stillbirth: A Case-Control Study**

Lindsey Butler

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Abstract: Previous studies suggest that risk of stillbirth is elevated by maternal exposure to air pollution. We conducted a retrospective case-control study of 1,097 women to examine the association between stillbirth related to placental abruption or placental insufficiency and maternal exposure to traffic related air pollution. We utilized distance to nearest roadway proximity metrics as a proxy for traffic-related air pollution exposure. No meaningful increase in the overall odds of placental-associated stillbirths was observed (adjusted OR: 1.1, 95% CI: 0.5-2.8). However, mothers living within 50 meters of a roadway had a 60% increased odds of experiencing a stillbirth related to placental abruption compared to mothers living greater than 200 meters away, This suggestive finding was imprecise due to the small case number in the highest exposure category (95% CI 0.6-4.0). Future studies of placental abruption with more precise exposure assessments are warranted.

## **P01.0720. Measuring Personal Environmental Exposures Using a Wearable Air Pollutant Monitor**

Elizabeth Lin

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**Abstract:** Traditional personal air pollutant monitoring systems include backpacks containing hand-held air monitors and filters/pumps which are worn for several days. Given the size, weight and cost of these sampling systems, use with vulnerable populations (i.e. pregnant women, infants) is not feasible. There has been limited development of analytical techniques to capture the cumulative exposure of an individual to multiple air pollutants. New exposure assessment tools are required to better study longitudinal environmental exposures. We have developed the Fresh Air wristband to profile personal organic air pollutant exposures using a non-selective passive sampling technique. Pollutants are collected onto a sorbent bar housed within a silicone wristband. The sorbent bar is coated with a thin-film polymer substrate which accumulates non-polar air pollutants with a log K<sub>ow</sub> ranging between 4 and 8. The wristband is worn by an individual for a multi-day period and then analysed using high resolution gas chromatography time-of-flight mass spectrometry with thermal desorption. With this personal exposure assessment tool, we can quantify the time-weighted averages of exposure to a panel of volatile and semi-volatile organic compounds during typical daily activities without impairing motion. We will present data on the functionality of the Fresh Air wristband as a non-selective passive air pollutant sampler. Application of this new personal exposure assessment tool in a cohort of 60 school-aged children residing in Springfield, MA will further be discussed. Improved assessment of exposure using the Fresh Air wristband across life stages (pregnancy, infancy, childhood) has the potential to produce a more comprehensive understanding of the air pollutants that mediate adverse health.

## **P01.0730. Household Air Pollution and Telomere Length in Rural Chinese Women Using Biomass Stoves**

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**Abstract:** Background: Short telomeres are associated with chronic disease and early mortality. Urban and traffic pollution has been associated with telomere attrition in adults and children. The associations of household air pollution from biomass stoves and telomere length are unknown. Objectives: To investigate the associations between household air pollution and telomere length in adult women. Methods: We conducted a repeated-measure (one summer and two winter seasons) panel study of 137 rural Chinese women (mean age=55 y), measured their 48-h personal exposure to fine particulate matter (PM<sub>2.5</sub>) and black carbon (BC), and collected their oral DNA that was analyzed for relative telomere length (RTL). Non-linear associations were assessed using natural cubic splines (2-4 DF). Multivariate mixed models were used to examine the relationship between air pollution exposure and telomere length. Results: Air pollution exposures ranged from 13-945 µg/m<sup>3</sup> (arithmetic mean=141, SE: 11) for PM<sub>2.5</sub> and 0.1-139 µg/m<sup>3</sup> (mean=4.1, SE: 0.4) for BC. Spline models illustrated that the associations between air pollution and RTL were non-linear. A 1-ln (µg/m<sup>3</sup>) increase in air pollution was associated with lower RTL (PM<sub>2.5</sub> [-0.45, 95% CI: -0.88, -0.02, p=0.04], BC [-0.81, 95% CI: -1.21, -0.39, p<0.001]) after adjusting for age, waist circumference, ethnicity, secondhand smoke, sodium intake, day of the week, and time of day. Additionally adjusting for ambient temperature reduced the effect of air pollution by 23-62% (BC [-0.62, 95% CI: -1.09, -0.15, p=0.01]; PM<sub>2.5</sub> [-0.17, 95% CI: -0.72, 0.39], p=0.54), which may be due to more frequent biomass burning to heat homes when the outdoor temperature is colder. Conclusion: Household air pollution exposure is associated with shorter telomeres in rural Chinese women cooking with biomass fuel, with stronger associations for BC than PM<sub>2.5</sub> mass.

## **P01.0740. Assessment of Household Air Pollution Exposure and Associated Health Effects from Burning Firewood and Yak Dung on the Eastern Tibetan Plateau**

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**Abstract:** Background: Cooking and heating with solid fuels produces high levels of household air pollution (HAP) and is a substantial contributor to the disease burden. This study assesses the sources, magnitudes, and chemical compositions of HAP in traditional Eastern Tibetan Plateau households; examines the perturbation of urine metabolome in response to the HAP exposure; and explores how these correlate with cookstove use, fuel type, cooking behaviors, and residents' overall health. Methods: We measured 24-hour personal exposure to PM<sub>2.5</sub> (n = 46) and kitchen area black carbon (BC) concentrations (n = 8), using MicroPEM and microAeth, respectively. We also measured particle-bound polycyclic aromatic hydrocarbon (PAH) (n = 12) and metal concentrations (n = 11) during post-analysis of the MicroPEM filter. We conducted household surveys (n = 24) regarding demographics, cookstove usage, fuel type, cooking behavior, and lifestyles. In addition, we collected fasting urine (n = 46) and applied untargeted metabolite profiling to monitor metabolic features and assess associations with measured HAP exposures. These data will be analyzed with bioinformatics approaches-Manhattan plot and Mummichog pathway analysis. Results: Our results reaffirm that burning firewood and yak dung, result in high PM<sub>2.5</sub> and BC exposures. The geometric mean (95% CI) concentration was 92.2 (12.5, 682.4) µg/m<sup>3</sup> for PM<sub>2.5</sub> and the mean ± standard deviation (SD) concentration was 5.8 ± 5.5 µg/m<sup>3</sup> for BC, 474.3 ± 584.3 ng/m<sup>3</sup> for EPA standard suite of 16 PAHs, respectively. The mean ± SD of concentrations of twenty-five detected metal elements ranged from 0.9 ± 1.1 (Co) to 1585.1 ± 1621.5 ng/m<sup>3</sup> (Si). Our statistical analyses illustrate high concentrations of PM<sub>2.5</sub>, BC, most PAHs and metals are significantly associated with village characteristics and household fuel types. Conclusion: Results from this study provide useful information for understanding the HAP exposure and related health risks in Tibetan communities.

## **P01.0750. Report Back of NO<sub>2</sub> and PM<sub>2.5</sub> Concentrations from a Community Based In-Home Exposure Monitoring Study**

Claire Schollaert

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Abstract: Exposure studies have been increasingly including report back of results to participants. This information can be used to decrease exposures, increase public understanding of science, and improve health. As part of the Center for Research on Environmental and Social Stressors in Housing across the Life Course (CRESSH), we reported back nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>2.5</sub>) results to participants of a home-based exposure monitoring study that took place over the course of a week in both a warm and cool season. Participants represented a diversity of racial/ethnic, socioeconomic, educational, and English language proficiency backgrounds. They also came from a diversity of housing situations (e.g., owner/tenant, single/multi-family, public/private). The report back process was developed in collaboration with GreenRoots, a community-based environmental justice organization, and Health Resources in Action, a national non-profit public health organization. The process included individualized reports and a community meeting, which established a space for participants to learn about general study results, ask questions, and discuss their interpretations. Results were presented using graphs reflecting daily averages of individual results for NO<sub>2</sub> and PM<sub>2.5</sub>, outdoor results of NO<sub>2</sub> and PM<sub>2.5</sub>, study-wide results for NO<sub>2</sub> and PM<sub>2.5</sub>, and national benchmarks and regulatory levels for comparative purposes. We also provided participants with information on the pollutants, strategies to reduce exposures, and projects to improve air quality in the community. Methods were developed and implemented in order to evaluate this report back process. Overall, this process was developed with a particular focus on the use of community-informed communication strategies, clear data visualization methods, and improving scientific literacy. We think that this strategy can be useful for other researchers who plan to report back results in future community-based exposure studies.

**P01.0760. Do Ambient Air Pollutant Concentrations during Pregnancy Impact Birth Weight among Women Living in Monroe County, New York? The Rochester Accountability Study**

Rui Li

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Abstract: Increased ambient air pollutant concentrations during pregnancy have been associated with reduced birth weight, but the etiologically-relevant time window during pregnancy is unclear. Therefore, we studied the association between gestational month ambient air pollutant concentrations and birth weight in Monroe County, NY (2005-2016). We also examined whether associations differed BEFORE implementation of several air quality policies (2005-2007), compared to DURING (2008-2013) and AFTER implementation (2014-2016). We used measurement of fine particles (PM<sub>2.5</sub>), black carbon (BC), ultrafine particles (UFP; <100nm), accumulation mode particles (AMP; 100-500nm), sulfur dioxide (SO<sub>2</sub>), and ozone (O<sub>3</sub>) in Rochester, NY (2005-2016) and birth certificate data for 76,500 singleton term births (37-42 gestational weeks at delivery) born to Monroe County residents. For each pollutant, we separately regressed birth weight against the mean concentration in each gestational month and the last 31 days of pregnancy (10 models). We then explored effect modification by PERIOD, season, infant gender, maternal employment, and pregnancy complications. Overall, there were no clear patterns of birth weight change associated with increased pollutant concentrations across gestational months. However, increased and decreased birth weights were associated with interquartile range increases in black carbon in the 1st gestational month (13.4g increase; 95% CI=3.4, 23.4), UFP in the 6th month (7.5g decrease; 95% CI=-14.5, -0.4), O<sub>3</sub> in the 1st month (15.8g decrease; 95% CI=-31.5, -0.1) and O<sub>3</sub> in the 6th month (17.2g increase; 95% CI=3.1, 31.4). There were also no patterns of effect modification by PERIOD, infant gender, maternal employment, pregnancy complications, or season. However, among Hispanic women only, increases in all pollutants, except O<sub>3</sub>, in multiple gestational months were associated with decreased birth weight. Further work is needed to understand these differences by ethnicity.

**P01.0770. The Effects of Melatonin on the Relationship between Air Pollution Levels and Biomarkers of Oxidative Stress and Platelet Activation in Healthy Young Adults**

Linchen He

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Abstract: Urinary free malondialdehyde (MDA) and 8-hydroxy-2'-deoxyguanosine (8-OHdG) as biomarkers of oxidative stress as well as soluble P-selectin as a biomarker of platelet activation have been associated with air pollution exposure. However, the results have not been consistent across studies. We hypothesize that this inconsistency might be due to modification of circulating melatonin, a free radical scavenger and a key factor in the DNA damage repair system, on MDA and 8-OHdG responses to reactive oxygen species induced by air pollution exposure. Melatonin also regulates PPAR $\gamma$ /FUNDC1/ mitophagy pathways, hence affecting P-selectin level. We conducted a longitudinal study involving 70 healthy young adults living on a hospital campus in Shanghai. Indoor and outdoor PM<sub>2.5</sub>, O<sub>3</sub>, and NO<sub>2</sub> were monitored throughout the study and combined with time activity pattern to estimate personal air pollution exposure. The results show that a 10% increase of urinary 6-sulfatoxymelatonin (aMT<sub>6s</sub>, a major metabolite of melatonin and highly correlated with circulating melatonin) was associated with a significant increase in urinary 8-OHdG by 2.4% [95% CI: 1.4%, 3.4%] and a significant decrease in urinary free MDA and soluble P-selectin by -1.5% [-2.4%, -0.6%] and -1.0% [-1.9%, -0.1%], respectively. Compared to unadjusted models (specified in parenthesis), models with urinary aMT<sub>6s</sub> as an effect modifier showed that 10  $\mu$ g/m<sup>3</sup> in PM<sub>2.5</sub> 12h personal exposure was associated with a change in urinary 8-OHdG by 11.0% [-2.4%, 24.3%] (unadjusted: -3.8% [-7.4%, -0.2%]), a change in urinary free MDA by 14.0% [2.4%, 25.7%] (unadjusted: -0.3% [-3.4%, 2.8%]), and 10  $\mu$ g/m<sup>3</sup> increase in NO<sub>2</sub> 12h personal exposure was associated with a change in P-selectin by 5.4% [-10.2%, 21.0%] (unadjusted: -5.3% [-9.5%, -1.1%]). Similar mediation effects were also observed for O<sub>3</sub>. These findings support the role of melatonin as a mediator for oxidative stress and platelet activation introduced by air pollution exposure.

## **P01.0780. Air Pollution and Metabolomics in Maternal Serum**

Qi Yan

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**Abstract:** Background: Studies have shown that maternal exposed to air pollution can increase the risk of a variety of neurodevelopmental disorders. However, air pollution cannot be considered a well-established risk factor, partially due to a lack of valid exposure assessment methodology. Assessing environmental metabolomic profiles using high-resolution metabolomics (HRM) is a novel tool to investigate air pollution exposure history and related biological mechanism. Objectives: The aim of this study is to comprehensively profile metabolomics in the blood of women in mid-pregnancy and identify perturbations in metabolites and metabolic pathways associated with air pollution exposure by using HRM. Methods: We retrieved stored maternal serum samples from the mid-pregnancy alpha-fetoprotein testing program in California for a largely immigrant Hispanic community of women living in the Central Valley of California, a region with high particulate air pollution exposures. We developed measures of air pollution exposure at the mothers birth address. By using HRM, we identified significant metabolites and metabolic pathways within 99 exposed mothers and 62 unexposed mothers. Statistical methods include univariates analysis, multivariates analysis, and pathway enrichment analysis. Results: A set of 3917 metabolic features resulting from HRM were used for discriminant analysis and pathway analysis. We have identified 25 metabolites which can properly classify the air pollution exposure status with over 80% accuracy. Pathway analysis showed that air pollution exposure associated with leukotriene metabolism, amino acid metabolism, and pyrimidine and purine metabolism pathways. Conclusions: We found that maternal exposed to air pollution during pregnancy could potentially affect inflammation and oxidative stress-related metabolism, which may then contribute to the development of neurodevelopmental disorders in the offspring.

## **P01.0790. Standardizing Methods for Acellular Measurement of Oxidative Potential**

Alison Traub

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**Abstract:** Exposure to air pollution is associated with a broad suite of adverse health effects. Oxidative potential (OP) - the ability of pollutants to cause oxidative stress, measured per unit concentration - has emerged as a promising, biologically relevant metric for assessing risk associated with atmospheric pollutants. Notably, acellular measurements of OP, when applied to airborne particulate matter (PM), have been shown to be associated with cellular inflammatory response, cause-specific mortality, and other adverse health outcomes. Further, acellular in vitro methods are well suited for analyzing the large numbers of samples required to produce exposure data to support epidemiology studies. A standardized methodology was developed and applied to stream-line the most common acellular OP assays: The ascorbate, glutathione, and dithiothreitol assays. The assays were standardized to improve their reproducibility through strategic incorporation of blanks, calibration solutions and positive controls. This improved methodology was applied to 350 PM<sub>2.5</sub> samples collected from sites across Toronto and Canada. The standardized method has substantially improved assay reproducibility: depletion of ascorbate in blanks (no added PM) and a positive control (2.5  $\mu\text{M}$  Cu<sup>2+</sup>) varied by less than 4% and 6% respectively across multiple analyses completed with two spectrophotometers over a three-month period. Further, the coefficient of variance for the analysis of ascorbate depletion across replicates of any single PM sample was typically within 4%. Similarly, coefficients of variance for the analysis of glutathione and dithiothreitol depletion rates were consistently within 15%. Most importantly, failed assays could be quickly identified. As OP analysis becomes more widespread, application of a standardized analysis approach will become essential to increase inter-study comparability of OP measurements, and enhance the feasibility of collaborative, large-scale studies of OP.

## **P01.0800. Effect of Confounding, Effect Modification, and Exposure Measures on the Association of Long-Term Ozone Exposure and Cause-Specific Mortality**

Ki-Do Eum

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**Abstract:** Introduction: Associations between long-term ozone (O<sub>3</sub>) exposure and cause-specific mortality have been demonstrated, although with varying exposure metrics and confounders. Methods: We assessed the association of warm season (April-September) averages of 1-hour daily maximum O<sub>3</sub> and cause-specific mortality for 22.2 million Medicare beneficiaries between 2000-2008. We modeled the national and regional associations between O<sub>3</sub> and rate of mortality using age, gender, and race stratified log-linear regression models. We examined confounding by including ecologic and neighborhood-level behavioral covariates and PM<sub>2.5</sub> estimated using spatio-temporal models. We also performed sensitivity analyses using exposure assessed as the warm season averages of daily 8-hour maximum and 24-hour average concentrations. We fit a log-linear model with a restricted cubic spline of O<sub>3</sub> to estimate the shape of the dose-response relationship between ozone and cause-specific mortality and examined effect modification of these associations by age, gender and race. Results: Our findings show that 1-hour maximum O<sub>3</sub> is significantly associated with an increased rate of death for all-cause (1.013 per 10 ppb increase; 95%CI: 1.012, 1.014), respiratory (1.036; 95%CI: 1.032, 1.039), cardiovascular (1.027; 95%CI: 1.025, 1.028) and lung cancer (1.016; 95%CI: 1.011, 1.020) mortality, but not for cancer mortality. Associations were generally strongest in the northeast US for all causes as compared to other US regions. Risk ratios were robust to adjustment for ecologic covariates, behavioral covariates and to PM<sub>2.5</sub>. Results remained significant but were attenuated when 8-hour daily maximum and 24-hour average measures of O<sub>3</sub> were used as the exposure measure, although 24-h averaged O<sub>3</sub> was associated with decreased all cause and cardiovascular mortality. Conclusions: Long-term exposure to O<sub>3</sub> was associated with increased mortality due to all-cause, respiratory, cardiovascular and lung cancer mortality.

**P01.0810. Association between Long-Term Exposure to Fine Particulate Matter Air Pollution and Mortality in a South Korean National Cohort**

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**Abstract:** Previous cohort studies in Europe and North America have reported the relationship between long-term exposure to fine particulate matter air pollution and human health. However, there have been few studies in other areas because of the lack of nationwide PM<sub>2.5</sub> regulatory air quality monitoring data. This study examined the association between long-term exposure to PM<sub>2.5</sub> and mortality in a South Korean national cohort. We included 275,337 of 20-65 years at baseline, who had survived and underwent health screening for 2002-2006 with follow-up data through 2013 from the National Health Insurance Service-National Sample Cohort. Individual exposures to PM<sub>2.5</sub> were calculated as 5-year averages of district-specific annual average predictions of PM<sub>2.5</sub> at annually-updated residential addresses for 2002-2006. PM<sub>2.5</sub> predictions in 250 districts were estimated by using predicted district-specific annual means of PM<sub>10</sub> multiplied by annual ratios of PM<sub>2.5</sub> to PM<sub>10</sub>. We used Cox proportional hazards models to estimate hazard ratios (HRs) and their 95% confidence intervals (CIs) of non-accidental (The International Classification of Diseases, 10th revision: A00-R99), cardiovascular disease (I00-I99), and respiratory disease (J00-J99) mortality per 10 micrograms per cubic meter increase in PM<sub>2.5</sub>. In the models, we adjusted for individual covariates such as income, type of health insurance, smoking status and district-level demographic and socioeconomic variables. We did not find associations between PM<sub>2.5</sub> and all mortality with statistically insignificant HRs. HR for respiratory mortality was higher than for cardiovascular mortality (HR: 1.48 [95% CI: 0.87, 2.51]; 0.97 [0.76, 1.25] for respiratory and cardiovascular disease mortality, respectively). Our study do not provide evidence for associations between long-term PM<sub>2.5</sub> exposure and mortality. Future studies should investigate our findings of no associations by including additional confounders and/or subgroup analysis.

## **P01.0820. Data Needs for Measuring and Modelling Personal Exposure to Air Pollution: How Much Is Enough?**

Juan Orjuela

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**Abstract:** Introduction: Impacts of daily activities and physical activity (PA) levels on personal exposure to air pollution are consistently understudied in epidemiological studies. Some researchers have included people's variable daily locations in their analysis and only a handful of publications mention the importance of breathing rates. Ignoring variables such as microenvironmental factors and inhalation rates introduces bias and uncertainty but estimating them for large populations can be challenging and expensive. This study presents a method for estimating inhaled doses based on limited collected data. Method: As part of the EU-funded PASTA project, we collected black carbon (BC) exposure concentrations, geolocation, and PA data from a free-living population (122 participants) in three European cities between 2015/16. Daily inhaled doses and average concentrations were analyzed as a function of travel mode, season, time of day and geolocation. Furthermore, half of the BC and PA data collected was used to develop regression models to estimate personal exposure concentrations and inhaled doses using one of three different kinds of input data: online survey data, a combination of GPS and survey data, and a combination of survey data and activity diaries. To assess the value of information, the results of each model were compared to calculated values using the remaining half of the data for validation. Results: Differences in personal exposures and inhaled doses for different travel mode users were statistically significant with, for example, cyclists inhaling 22% more on average than motorists. Inhaled doses were shown to be adequately modelled through a combination of surveys and limited monitoring data. The additional effort of collecting GPS data is not justified in some cases. Conclusion: Limited data collected from personal monitors can be used to develop statistical models that estimate inhaled doses of air pollution of larger cohorts.

## **P01.0830. Short-Term Exposures to Traffic-Related Air Pollution and Pulse Wave Velocity in a Cohort of Children and Youth with Type 1 Diabetes**

Jessica Montresor-Lopez

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**Abstract:** Background: Changes in vascular function may play a role in the association between short-term exposures to particulate matter (PM) air pollution and cardiovascular events. However, few studies have evaluated whether arterial stiffness increases in response to acute PM exposures, particularly among individuals who are at higher risk for developing cardiovascular disease (CVD), such as children and young adults with type 1 diabetes (T1D). Objectives: We examined the relationship of short-term exposures to PM<sub>2.5</sub>, elemental carbon (EC) and Atmospheric Dispersion Modeling System (ADMS)-Roads traffic-related PM near roadways with pulse wave velocity (PWV), a measure of arterial stiffness, using data from the SEARCH for Diabetes in Youth Study (SEARCH). Methods: PWV, lifestyle and demographic data were collected at a SEARCH study visit. Pollutant exposures were estimated using spatio-temporal models and assigned to the residential address of each participant for 7 days prior to the study visit. We estimated associations between different exposure windows (daily and weekly averages) of each air pollutant and PWV using separate generalized linear models adjusted for demographic and lifestyle variables. Results: Approximately 44% of the 352 participants were female and 86% were white, with a mean age of 14.6 years. In fully adjusted models, comparing the 25th and 75th percentiles of PM<sub>2.5</sub> mass exposures on lag day 0 resulted in a 5.8% higher PWV (95% CI: 0.7%, 11.2%). No other significant associations were observed. Conclusions: In this population of youth with T1D, PWV was associated with PM<sub>2.5</sub> mass on lag day 0. However, no associations were observed for acute exposures to other traffic-related air pollutants. In further analysis, we will examine the relationships of PM<sub>2.5</sub> mass and traffic-related air pollutant exposures with additional measures of cardiovascular structure and function.

## **P01.0850. Short-Term Exposure to PM2.5 Associated with Cardiovascular and Cerebrovascular Mortality in Mexico City from 2004-2013**

Iván Gutiérrez-Avila

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**Abstract:** Background. The association between short-term exposure to particles with aerodynamic diameter  $\leq 2.5 \mu\text{g}$  (PM2.5) and daily mortality has been extensively described in cities of developed countries. Only limited evidence exists on short-term exposure to PM2.5 associated with specific causes of cardiovascular and cerebrovascular mortality in cities of developing countries. Methods. We obtained daily mortality records for Mexico City for 2004-2013 for all cardiovascular and cerebrovascular causes, ischemic heart disease, hemorrhagic and ischemic stroke in people  $\geq 25$  and  $\geq 65$  years old. Daily exposure to PM2.5 was assessed with estimates from a new hybrid spatiotemporal model using satellite measurements of Aerosol Optical Depth (AOD-PM2.5) and compared to PM2.5 measurements from ground-level monitoring stations with missing data estimated with Generalized Additive Models (GAM-PM2.5). We fitted Poisson regression models with distributed lags to evaluate the association between short-term exposure to AOD-PM2.5 and GAM-PM2.5 with daily cardiovascular and cerebrovascular mortality. Results. We found a 1.22% (95% CI: 0.17-2.28) increase in cardiovascular mortality and 3.43% (95% CI: 0.10-6.28) increase in cerebrovascular mortality per 10- $\mu\text{g}/\text{m}^3$  increase in AOD-PM2.5 for the cumulative exposure over two days (lag0-1). The association between AOD-PM2.5 with hemorrhagic stroke was 4.01% (CI 95%: 0.37-7.77) for same day exposure (lag0). People  $\geq 65$  years old showed the largest associations for cardiovascular mortality (2.29% increase, 95% CI:0.98-3.63) and cerebrovascular mortality (4.70% increase, 95% CI:0.39-9.19) for the cumulative exposure over six days (lag0-6). Associations were slightly smaller using GAM-PM2.5. Conclusions. Our results suggest that PM2.5 pollution should be seen as a modifiable risk factor in the prevention of acute cardiovascular and cerebrovascular events in Mexico City.

## **P01.0860. Assessment of Particle Oxidative Potential as an Air Pollution Exposure Metric: A Systematic Review**

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**Abstract:** Ambient particulate air pollution is linked to numerous acute and chronic health outcomes. The standard approach to measuring particulate exposure has been to estimate particle mass concentration. New measures account for oxidative potential, the ability of particles to cause oxidative stress in the body. There has been no systematic comparison of particulate air pollution exposure assessment methods between those that incorporate oxidative potential and those that do not. The aim of this review is to determine if associations between particulate air pollution exposure and health outcomes are stronger when oxidative potential is used as the exposure metric, in comparison to particle mass concentration. The databases Medline and Embase were searched from inception to 28 March 2018 for studies that reported an association between particulate air pollution exposure and a health outcome in a human population, and in which exposure was measured by both particle mass concentration and oxidative potential. Study quality was assessed using a US National Toxicology Program instrument. We identified 18 publications meeting the selection criteria. The most common oxidative potential assay was antioxidant depletion in synthetic respiratory tract lining fluid, used in 12 articles. The rate of consumption of dithiothreitol was also frequently used as an oxidative potential assay and appeared in 5 studies. The dithiothreitol assay most consistently produced stronger effect estimates, as 10/14 endpoints showed higher point estimates of associations compared to particle mass concentration estimates. Other assays showed mixed results. To date there is no consistent evidence that oxidative potential is more strongly associated with health outcomes than particle mass concentrations; however, these assays do have the advantage of not treating all particles as equally harmful and further work should explore which specific assays are most relevant to evaluating air pollution health risks.

## **P01.0870. Acute Changes in Augmentation Index and Pulse Wave Velocity Following Controlled Exposures to Cookstove Air Pollution in the Subclinical Tests of Volunteers Exposed to Smoke (Stoves) Study**

Ethan Walker

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Abstract: Household air pollution from solid fuel cookstoves is a leading cause of morbidity and mortality globally. Nearly half of the estimated 2.5 million premature deaths from cookstoves in 2016 were due to cardiovascular disease. There have been attempts to design improved cookstoves, yet it is unclear if they meaningfully improve health. The aim of this study was to assess the acute effects of pollution from multiple stoves on cardiovascular outcomes using a crossover controlled exposure design. Forty-eight young, healthy participants were assigned to six, two-hour exposure treatments: emissions from five cookstoves with a target concentration for fine particulate matter (liquid petroleum gas: 10  $\mu\text{g}/\text{m}^3$ ; semi-gasifier: 35; fan rocket: 100; rocket elbow: 250; open fire: 500), and filtered air control (0  $\mu\text{g}/\text{m}^3$ ). Augmentation index (AIx) and pulse wave velocity (PWV) were assessed before and three timepoints (zero, three, and 24 hours) after each treatment. Linear mixed models were used to assess differences in AIx and PWV for each treatment compared to filtered air. Preliminary results suggest elevated levels of AIx three hours after fan rocket (1.7 percentage points; 95% confidence interval [CI]: -1.5, 4.9) and open fire treatments (2.4 percentage points; 95% CI: -0.8, 5.6) compared to filtered air. PWV levels were higher 24 hours after all treatments compared to filtered air. For example, the difference between semi-gasifier and filtered air was 0.16 meters/second (m/s) (95% CI: -0.007, 0.33). No other differences were observed except higher PWV three hours after semi-gasifier treatment (0.18 m/s; 95% CI: 0.005, 0.36). AIx and PWV are established indicators of future cardiovascular risk. Our results suggest both may increase in healthy adults after short-term exposure to cookstove pollution. Along with complementary results from field studies, our results may provide insight into benefits of new and current cookstove technologies. This abstract does not represent EPA policy.

**P01.0880. Association between PM2.5 and Systemic Autoimmune Rheumatic Diseases: A Cohort Study in Taiwan from 2001 to 2011**

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**Abstract:** Background: Systemic autoimmune rheumatic diseases (SARDs) are a group of diseases with abnormally inflammatory reactions, such as dermatomyositis (DM), polymyositis (PM), systemic sclerosis (SSc). The pathogenesis of systemic autoimmune diseases is still unclear. Only a few studies accessed the relation between exposure to air pollution and systemic inflammation and provide inconsistent results. We conducted a prospective cohort study to investigate the associations between fine particulate matter (PM2.5) and SARDs, namely DM, PM, SSc, in Taiwan. Methods: The study population were obtained from Taiwan National Health Insurance Research Database (NHIRD) and followed up from 2001 to 2011. All participants were followed end when diagnosis of SARDs (DM, PM, SSc), or death, or end of the study. We developed a model integrated 3-km AOD with meteorological parameters and land use data to predict daily PM2.5 concentrations across Taiwan. We performed a time dependent Cox models to assess the effects of yearly average PM2.5 on SARDs (DM, PM, SSc). The results were reported as hazard ratios (HRs) with 95% confidence interval (CI). Results: A total of 3119 DM cases, 3259 PM cases, and 2824 SSc cases were identified during the study period. The mean age of DM, PM, and SSc cases were 54.4±18.7, 53.8±16.8, and 49.9±15.9 years, respectively. After adjusting for sex, age, and socioeconomic status, the results showed that exposure to an Interquartile range (IQR) increase in PM2.5 level (14.29 µg/m<sup>3</sup>) were associated with an approximately 48% increased risk of DM (95% CI 1.39--1.59) and a 23% increased risk of PM (95% CI 1.16-1.32). We did not observe significant associations between PM2.5 and SSc. Conclusions: Our study suggests that exposure to PM2.5 may increase the risk of DM and PM. The future studies would be needed to confirm these associations, and explore potential toxicants on SARDs other than PM2.5.

## **P01.0890. Effect of Long-Term Exposure to Ambient Fine Particulate Matter on Renal Function in the PURSE-HIS Cohort**

Zoe Petropoulos

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**Abstract:** **BACKGROUND:** Studies on the association between fine particulate matter (PM<sub>2.5</sub>) and kidney disease are limited. We investigated the association between PM<sub>2.5</sub> exposure and renal function in the Urban, Rural, Semi-urban Endovascular disease and Holistic Intervention Study (PURSE-HIS) cohort in India. **METHODS:** The study included 8,080 randomly selected subjects (mean age: 42 years; 58% female). We used PM<sub>2.5</sub> estimates developed for Global Burden of Disease as exposure at residence. Fasting blood samples were used to assess serum creatinine and the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation was used to derive the estimated glomerular filtration rate (eGFR). Generalized linear regression models, with stratification by diabetes and hypertension status, were used to test the association between PM<sub>2.5</sub> and urinary albumin. Logistic regression was used to estimate the odds of eGFR < 60 ml/min/1.73 m<sup>2</sup>, a cutoff for chronic kidney disease (CKD). All models were adjusted for age, sex, waist circumference, and smoking status. **RESULTS:** In linear regression models, an interquartile range (IQR) increase in PM<sub>2.5</sub> (3.0 µg/m<sup>3</sup>) was associated with an increase in urinary albumin (1.4 mg/L [95% CI: -1.5, 4.4]). A similar association was found in non-diabetics (1.2 mg/L [95% CI: -0.9, 3.3]), but not among diabetics. Stratification by hypertension did not significantly modify the relationship. An IQR increase in PM<sub>2.5</sub> was associated with higher odds of CKD (OR: 1.14 [95% CI: 1.06, 1.23]). **CONCLUSIONS:** Exposure to PM<sub>2.5</sub> was significantly associated with CKD. PM<sub>2.5</sub> was associated with urinary albumin in non-diabetics, an indication that PM<sub>2.5</sub> may have an effect on the kidney microvasculature. Longitudinal follow up is necessary to better understand the relationship between PM<sub>2.5</sub> exposure and kidney injury and dysfunction.

## **P01.0900. Health Benefits of Ozone Warning System in Three Major Cities of South Korea: A Regression Discontinuity Design**

Honghyok Kim

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**Abstract:** Background: Ozone warning system is operating in cities of South Korea. The first stage warning is issued if 1-hour average of ground-level ozone exceeds 120 ppb. Using a case-crossover design combined with a regression discontinuity design (RDD), this study assessed whether the warning system provides health benefit Methods: Since ozone warnings are alerted independently over zones within a city and individuals were assumed to be exposed to ground-level ozone differently (e.g. due to outdoor activities), a fuzzy RDD was applied to estimate the causal effect of the first stage warning on hospital visits and hospitalizations for allergic rhinitis (J30), asthma (J45), pneumonia (J12-18) and chronic lower respiratory disease (J40-44) in three major cities of South Korea (Seoul, Busan, and Daegu) during the period of 2008-2013. Based on a time-stratified case-crossover design, we applied a conditional Poisson regression with over-dispersion. Temperature, relative humidity, holiday and influenza epidemic were adjusted for. Lag effects up to previous 5 days of exposure were considered. Results: A total of 30, 28, and 21 days exceeded 120 ppb of 1-hour maximum of ground-level ozone in Seoul, Busan, Daegu respectively. The first stage warning led to reductions (intent-to-treat effects) in hospital visits and hospitalizations for allergic rhinitis, asthma, pneumonia and chronic lower respiratory diseases. The decrements differed by the health outcomes and the cities, and ranged from 6.0% (95% CI: -0.6 to -11.1) in hospital visit for asthma in Seoul to 23.4% (95% CI: -0.18 to 41.5) in hospitalization for asthma in Busan. We also found evidence on some harvesting effects (i.e. increases of hospital visits and hospitalizations following the initial reductions by the warning). Conclusion: Ozone warning system in South Korea reduces hospital visits and hospitalizations for respiratory diseases.

## **P01.0910. Childhood Incident Obesity and Traffic-Related Air Pollution among School-Aged Children**

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**Abstract:** Background: Recent studies suggest that traffic-related air pollution exposure may play a significant role in childhood obesity epidemic. Objectives: The present study was conducted to examine the longitudinal association between traffic-related and ambient air pollution exposures and childhood overweight or obesity (OWOB) onset. Methods: We recruited 3,075 normal weight kindergarten or first grade children from participants in the prospective cohort of southern California Children's Health Study (CHS). Individual covariates were reported annually through questionnaires and OWOB status (n=768) were categorized based on body mass index (BMI) and referred to CDC growth chart. Near-roadway pollution (NRP) was represented by nitrogen oxides (NO<sub>x</sub>), and was estimated based on residential addresses using a line source dispersion model accounting for traffic-volume, proximity, and meteorology. Ambient air pollutants including ozone, nitrogen dioxide, and particulate matter were measured at central site monitors in 13 study communities. We used proportional hazard model to analyze the association of annual averaged NRP and ambient air pollution exposures during one-year before baseline visit (2002-2003) with the risk of developing OWOB during an 8-year study follow-up. Results: Two standard deviation (5.41 ppb) increase of NRT of non-freeway NO<sub>x</sub> during one-year before baseline visit was associated with 12% increased risk of developing OWOB [HR=1.12, 95% CI = (1.01, 1.25)] during follow-up. The association was stronger among boys [HR=1.13, 95%CI= (1.01, 1.28)] compared to girls [HR=1.06, 95%CI= (0.85, 1.31)] (interaction P-value=0.043). Additionally, the significant association of non-freeway NO<sub>x</sub> and increased risk of developing OWOB was replicated in an independent CHS cohort sample of 2,474 participants and were followed with an average 6 years. Conclusion: Children exposed to higher non-freeway NO<sub>x</sub> were at higher risk of developing OWOB in later life.

## **P01.0920. Association between Health-Related Quality of Life and Air Pollution in Female in Korea**

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**Abstract:** Background; Exposure to air pollution in humans can lead to a reduction in physical and mental function before it progressed to disease development and morbidity. These adverse health effects are reflected health-related quality of life (HRQOL), the level of mental emotional and physical functioning in daily life. We assessed the impact subjective health status on exposure to air pollution in female in Korea. Methods; We recruited 2,836 women who were repeatedly surveyed three or more times in the Korean Health Panel (KHP) from 2009 to 2013. We matched each the EQ-VAS score of respondents with 24-hr averages of the air quality indexes and meteorological indexes obtained from the residence based on the date of survey by 8 administrative regions. Generalized linear mixed model was applied to estimate relative risks (RRs) and 95% confidence intervals (CIs) in single and multi-pollutants model. Results; The total number of cases over 5 years was 12,915. We found statistically significant relationships between education level, smoking status, marital status, weekly sleeping time, morbidity of disease, income and NO<sub>2</sub> level in the ambient air in female. The score was reduced 0.396 (-0.700 - -0.092) at lag 0 and 0.330 (-0.631 - -0.030) at lag 1 per 10 ppb in multi-pollutants model. Conclusion; This study suggested that short-term exposure to NO<sub>2</sub> could adversely affected health-related quality of life.

## **P01.0930. Are Ambient Volatile Organic Compounds Environmental Stressors for Heart Failure?**

Jinjun Ran

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**Abstract:** Background: Numerous epidemiological studies have demonstrated the health impacts of the criteria air pollutants on heart failure (HF). However, evidence on detrimental effects of ambient volatile organic compounds (VOCs) is insufficient. The present study aimed to estimate the short-term effects of ambient VOCs on emergency hospital admissions for HF in Hong Kong. Methods: Daily VOCs concentrations from April 2011 to December 2014 were collected from the Hong Kong Environmental Protection Department. Emergency hospital admissions for HF were obtained from the Hospital Authority of Hong Kong. Generalized additive model (GAM) integrated with the distributed lag model (DLM) was used to estimate the excess risks of HF hospitalizations associated with ambient concentrations of each VOC groups - alkane, alkene, alkyne, benzene and substituted benzene, while adjusting for time trend, seasonality, weather conditions, and calendar effect. Results: We observed short-term effects of alkyne and benzene on HF hospitalizations. The cumulative effect over 0-6 lag days (dlm0-6) for an IQR increment of alkyne (1.17ppb) was associated with 4.2% (95%CI: 1.18% to 7.26%) increases of HF emergency hospitalizations, while the corresponding effect estimate over dlm0-2 for benzene per IQR (0.43ppb) was 2.7% (95%CI: 0.39% to 5.04%). Each VOC group was significantly associated with emergency HF hospitalizations in men. Conclusions: Ambient volatile organic compounds, particularly alkyne and benzene, might be environmental stressors for heart failure in Hong Kong population, especially for men.

## **P01.0940. A Population-Based Birth Cohort Study of the Association between Childhood-Onset Asthma and Exposure to Industrial Air Pollutant Emissions**

Stephane Buteau

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**Abstract:** Background: Studies of the association between air pollution and asthma onset have mostly focused on urban and traffic-related air pollution. We investigated the associations between exposure to industrial emissions and childhood-onset asthma in a population-based birth cohort in Quebec, Canada, 2002-2011. Methods: The cohort was built from administrative health databases. We developed separately for PM<sub>2.5</sub> and SO<sub>2</sub> different metrics representing children's time-varying residential exposure to industrial emissions: 1) tons emitted yearly by all industries within 2.5 km; 2) distance to the nearest "major emitter" ( $\geq 100$  tons/year) within 7.5 km; 3) wind and inverse-distance weighted emissions of the nearest major emitter within 7.5 km. To handle the large number of zeros (i.e., children unexposed) we decomposed the exposure variable into two covariates simultaneously included in the regression model: A binary indicator of exposure and a continuous exposure variable centered at the mean value among exposed children. We performed Cox models using age as the time axis, adjusted for gender, material and social deprivation and calendar year. We indirectly adjusted for unmeasured secondhand smoke. Results: The cohort included 722,667 children and 66,559 incident cases of asthma. Across the different exposure metrics, mean percentage changes in the risk of asthma onset in children exposed to the mean relative to those unexposed ranged from 4.5% (95%CI: 2.8, 6.3%) to 10.6% (95%CI: 6.2, 15.2%) for PM<sub>2.5</sub> and, from 1.1% (95%CI: -0.1, 3.3%) to 8.9% (95%CI: 7.1, 11.1%) for SO<sub>2</sub>. Indirect adjustment for secondhand smoke marginally influenced the associations. Among children exposed, the risk of asthma onset increased with the magnitude of the exposure for all metrics, except the distance to the nearest major emitter of SO<sub>2</sub>. Conclusion: In this population-based birth cohort, residential exposure to air pollutant emissions from industries was associated with childhood-onset asthma.

**P01.0950. Indoor and Outdoor Pollution: Assessment of PM2.5 in Yopougon (Abidjan, Cote D'ivoire)**

Ahua Kouao

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**Abstract:** Background: Biomass combustion is a major source of indoor air pollution. In Côte d'Ivoire, 30.5 % of the population in the urban areas use biomass for cooking. Few studies have investigated indoor and outdoor air pollution in urban area in West Africa. The aim of this study was to determine indoor and outdoor pollutants concentrations in household in Yopougon (Côte d'Ivoire). Methods: Indoor and outdoor air quality was investigated at two sites Andokoi and Lubrafrique in Yopougon. Questionnaires were used to collect demographic characteristic and exposure history in 109 households (Andokoi, n = 65; Lubrafrique, n = 44). Assessment of indoor and outdoor air quality were done simultaneous during 48 hours in each household with Quest EVM-7 device. Statistic test Chi square and multivariate logistic regression were used to compare the sites and association between independent variables with pollutants. Results: Average concentrations of indoor PM2.5 for Andokoi and Lubrafrique were respectively,  $38 \pm 21 \mu\text{g}/\text{m}^3$  and  $116 \pm 64 \mu\text{g}/\text{m}^3$ . Also, average concentrations of outdoor PM2.5 for Andokoi and Lubrafrique were  $108 \pm 88 \mu\text{g}/\text{m}^3$  and  $34 \pm 21 \mu\text{g}/\text{m}^3$  respectively. Indoor and outdoor concentration of PM2.5 at Andokoi were higher than concentration of PM2.5 at Lubrafrique ( $p= 0.00$ ). An association was found between both number of cooking times [6.70 (1.23 - 36.57)], smoking [0.05 (0.00 - 0.93)] and concentration of indoor PM2.5. Concentration of outdoor PM2.5 were associated with the closeness of household to industrial area [9.43 (1.54 - 57.58)], method of smoking fish/meat [15.05 (2.15 - 105.32)], indoor PM2.5 [6.78 (1.14 - 40.01)] and ambient temperature [34.32 (3.03 - 388.22)]. Conclusions: Average concentration of indoor and outdoor PM2.5 were often more than WHO guideline value for PM2.5 ( $25 \mu\text{g}/\text{m}^3$ ). We need to investigate the relationship between exposure to indoor household air pollution and respiratory diseases in the population.

## **P01.0960. Effect of Long-Term Exposure to Fine Particulate Matter on Incident Dyslipidemia: A Cohort Study**

Yacong Bo

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**Abstract:** Background: Evidence about effects of long-term exposure to fine particulate matter (PM2.5) air pollution on the development of dyslipidemia is limited. This study aimed to investigate the associations between long-term ambient PM2.5 exposure and incident dyslipidemia in a large cohort. Methods: We studied 76,618 participants aged 18 years or above from a cohort who participated in a standard medical examination program between 2001 and 2014 in Taiwan. The PM2.5 concentration at each participant's address was estimated using a satellite-based spatio-temporal model at a high resolution (1x1 km<sup>2</sup>). Cox proportional regression hazard model was used to examine the associations between long-term exposure to ambient PM2.5 and the development of dyslipidemia. Stratified and sensitivity analyses were further conducted to examine the potential modifiers and the stability of these associations. Results: Every 10 µg/m<sup>3</sup> increment in the 2-y average PM2.5 concentration was associated with an increase of 4% in the risk of dyslipidemia development [hazard ratio=1.04 (95%CI: 1.02-1.05)]. Compared to the participants with the 1st tertile of PM2.5 exposure, participants exposed to the 2nd and 3rd tertiles of PM2.5 were associated with a hazard ratio of 1.07 (95%CI: 1.05-1.10) and 1.09 (95%CI: 1.06-1.12) in incident dyslipidemia, respectively. Sensitivity analysis generally yielded similar results. Stratified analysis suggested that participants with diabetes had higher effects of long-term PM2.5 exposure on dyslipidemia development. Conclusion: Long-term exposure to ambient PM2.5 is associated with an increased risk of developing dyslipidemia. Global strategies on air pollution reduction are needed to prevent dyslipidemia development.

## **P01.0970. Spatial and Temporal Patterns of Ambient Ultrafine Particles (UFP) in Communities Along an Aircraft Arrival Trajectory**

Chloe Kim

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**Abstract:** Background: Ultrafine particles (UFP) from aircraft are of concern due to their high emission rates and potential adverse health effects, but are challenging to characterize given their spatial and temporal variability. Recent studies report elevated UFP concentrations across large areas downwind from airports, but have not had sufficient data for source attribution. Our objective was to characterize aviation contributions to UFP concentrations under various meteorological conditions using highly-resolved flight activity data. Methods: We measured particle number concentration (PNC; a proxy for UFP) and meteorology from April to September 2017 at six ground-level sites that were varying distances from an arrival flight path into Boston Logan International Airport. Concurrent flight activity data were obtained from the U.S. Federal Aviation Administration. We compared PNC distributions as a function of meteorological conditions and flight activity, and constructed regression models for source attribution. Results: PNC distributions differed as a function of meteorological conditions and runway usage. Monitoring sites near the airport had similar hourly median PNC levels when the arrival runway was closed versus fully operational, but there was a 1-2 fold increase in 95th and 99th percentile PNC. Regression models provided insight regarding contributions of individual flights and dependence on meteorological conditions. Discussion: Our findings suggest a strong and intermittent contribution from arrival aircraft at sites in closer proximity (4~7km vs. 9~17km) to the airport. Further, diurnal patterns of PNCs, especially at the upper tails of the distribution, are suggestive of aircraft activity. Our site selection and availability of highly-resolved flight activity data, along with the use of real-time concentration measurements, reduces the potential confounding by traffic sources and allowed us to determine aircraft contributions to measured PNC.

**P01.0980. Acute Changes in Blood Pressure Following Controlled Exposures to Cookstove Air Pollution in the Subclinical Tests of Volunteers Exposed to Smoke (STOVES) Study**

Kristen Fedak

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Abstract: Exposure to household air pollution from cookstoves is a top risk factor for disease globally; cardiovascular diseases make up about half of the burden. However, the association between household air pollution and cardiovascular effects is not well characterized; health assessments often rely on data from other sources (e.g. cigarette smoking, ambient fine particulate matter [PM<sub>2.5</sub>]). Evidence specifically for the cardiovascular impacts of wood smoke continues to be mixed. We conducted a controlled human exposure study to investigate acute responses in blood pressure following cookstove-generated pollution exposure. Forty-eight young, healthy subjects were assigned to six, two-hour exposures: five cookstove treatments at target PM<sub>2.5</sub> concentrations representative of the stove's emissions (liquid petroleum gas [LPG], 10ug/m<sup>3</sup>; semi-gasifier, 35ug/m<sup>3</sup>; fan rocket, 100ug/m<sup>3</sup>; rocket elbow, 250ug/m<sup>3</sup>; open fire, 500ug/m<sup>3</sup>) and a filtered air control (0ug/m<sup>3</sup>). Mixed models were used to estimate associations between treatments and blood pressure. At 24 hours post-exposure, systolic pressure was on average 2-3 mmHg higher for all treatments compared to the control, except the rocket elbow stove, which was not different than control. For example, the estimated difference for the LPG stove compared to control was 3.1 mmHg (95% CI, 1.0-5.3). No clear or consistent differences were observed for systolic pressure immediately post-exposure or three hours post-exposure, or for diastolic pressure at any time point or treatment. These results, combined with evidence from other research, suggest that short-term exposure to cookstove-generated air pollution may adversely impact blood pressure in healthy young adults, even at low PM<sub>2.5</sub> concentrations and for stove technologies considered to be some of the cleanest available in many locations worldwide. Further analyses will consider exposure-response and additional pollutants. [This abstract does not represent EPA policy.]

## **P01.0990. Chemical Composition and Emissions Factors for Cookstove Startup (Ignition) Materials**

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**Abstract:** Exposure to household air pollution from residential cookstoves is a leading risk factor for disease globally. Previous work suggests that a disproportionate fraction of emissions can occur during cookstove startup; however, these data are limited to a few materials and pollutants. This study is the first to isolate emissions from cookstove startup across a range of startup materials and pollutants. Laboratory tests were conducted to measure emissions from commonly used cookstove startup materials: kerosene, plastic bags, newspaper, fabric, food packaging, rubber tire tubes, footwear, kindling, and wood shims. Tests were designed to isolate emissions from the startup material, using a generic cookstove to simulate a real-world cookstove startup process. We measured pollutants relevant to health and climate, including: carbon monoxide, carbon dioxide, methane, fine particulate matter mass (PM<sub>2.5</sub>), PM<sub>2.5</sub> elemental and organic carbon, volatile organic compounds (e.g., benzene, toluene), and carbonyls (e.g., formaldehyde, acetaldehyde). Emissions varied substantially across materials on a per-startup event basis. For example, PM<sub>2.5</sub> emissions were lowest for food packaging (8 mg/startup) and plastic bags (2 mg/startup) and highest for kerosene (496 mg/startup) and kindling (355 mg/startup). Carbon monoxide emissions ranged from 30 mg/startup (plastic bags) to 999 mg/startup (kerosene). Emissions of carcinogens and other hazardous pollutants similarly varied by one to two orders of magnitude between materials. Our results demonstrate that startup materials can contribute substantially to the overall emissions from a cooking event. Startup material choice is particularly important for cleaner stove/fuel combinations, where emissions from the main cooking event are lower and the contribution from startup material is proportionally larger. The incremental increase in emissions from startup materials is expected to have a larger marginal health impact with cleaner stoves.

## **P01.1010. Comparing Air Pollution Modelling and Monitoring for Bushfire Smoke Health Impact Assessment in Australia**

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Abstract: Fine particulate matter (PM<sub>2.5</sub>) is causally associated with cardiovascular and respiratory morbidity and mortality. Over recent decades the Sydney Greater Metropolitan Region population of five million have been repeatedly exposed to extreme levels of PM<sub>2.5</sub> in smoke from bushfires, planned and unplanned. To date, estimates of historical exposure and related health effects have been based only on sparse monitors. The aim of this study is to compare existing estimates of exposure and health impact with those based on Chemical Transport Modelling (CTM) and blended surfaces; and to determine whether any differences are important for understanding the public health impact of bushfire smoke. Three methods of estimating PM exposure attributable to bushfires in Sydney will be compared. First, exposure based on only PM monitor interpolation will be compared to exposure based only on CTM. The former of these assessments is the subject of a paper under embargo until mid-April 2018. Comparisons of the magnitude and distribution of exposure and health effects will be presented. Developing results from a third 'blended' exposure surface will also be presented. This third exposure estimate is based on Bayesian blending of the monitor and CTM surfaces. A main aim of this work is to determine whether CTM predictions of future exposure can be bias-corrected based on the previous relationship between monitors and CTM, i.e. can predictions of future exposure be improved by taking into account recent model performance? Health impact will be quantified in terms of attributable premature mortalities and hospitalisations for cardiovascular and respiratory disease. The distribution and magnitude of these health effect estimates from the three exposure models will be compared to determine if there is a meaningful difference for understanding the public health impact of bushfire smoke.

## **P01.1020. A Multi-Provincial Study of Air Pollution Exposure in Rural and Peri-Urban China**

Martha Lee

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**Abstract:** Background: Coal and biomass burning for household cooking and heating is a major source of exposure to air pollutants including fine particulate matter (PM<sub>2.5</sub>). Compared with urban air pollution, little is known about air pollution exposures in rural and peri-urban settings, particularly among men. Objective: Assess personal exposures to PM<sub>2.5</sub> among men and women ages 40-79 living in peri-urban villages in northern (Beijing, Shanxi) and southern China (Guangxi). Methods: We enrolled 782 participants into the INTERMAP China Prospective Study from these three regions and measured their integrated gravimetric personal exposures to PM<sub>2.5</sub> (Apex pumps; Harvard PEMs; 37 mm PTFE filters) for 2 days in heating and non-heating seasons and also collected information on fuel and energy use patterns. Results: Geometric mean daily exposures to PM<sub>2.5</sub> across sites and seasons ranged from 60 (95% CI [56, 64], Guangxi - heating season) - 134 (95% CI [122, 147], Shanxi - heating season) ug/m<sup>3</sup>. A seasonal difference was observed in the northern sites (GM = 96 ug/m<sup>3</sup>, 95% CI [90, 101] in heating versus 88 ug/m<sup>3</sup> [83, 94] in non-heating). Exposures were highest in Shanxi (GM = 120 ug/m<sup>3</sup>, 95% CI [113, 128]), followed by Beijing (93 ug/m<sup>3</sup> [87, 99]) and Guangxi (60 ug/m<sup>3</sup> [56, 64]). This trend persisted across season and gender. The proportion of participants using solid fuels was highest in Beijing (95%), followed by Shanxi (75%), and Guangxi (62%). Notably, individuals not using solid fuels for cooking and heating (GM = 92 ug/m<sup>3</sup> [83, 102]) had similar exposures to individuals using solid fuels (93 ug/m<sup>3</sup> [89, 97]). Conclusion: Use of solid fuels has persisted across northern and southern China. Exposures across all demographic groups and seasons exceeded the WHO 24-h air quality guideline of 25 ug/m<sup>3</sup>. On average, exposures in southern China were half that of northern China, where heating is an important energy use practice.

## **P01.1030. Incorporating Snow and Cloud Fractions in Random Forest to Estimate High Resolution PM2.5 Exposures in New York State**

Jianzhao Bi

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Abstract: Satellite aerosol optical depth (AOD) has been widely used to estimate the ground-level PM2.5 concentrations, but cloud/snow covers often lead to a large proportion of non-random missing AOD, causing difficulties in generating fully covered and unbiased PM2.5. Among the current approaches to address the data gap issue, few have considered the cloud-AOD relationship and none of them considered the snow-AOD relationship. This study aims to examine the influence of satellite-retrieved snow cover on AOD and PM2.5, and to generate accurate PM2.5 predictions in the areas with extensive snow cover. We chose New York State as our study domain since AOD missing rate here was ~ 90% and a large part of them was due to snow cover in winter. To estimate the missing AOD, a gap-filling model with cloud/snow fractions and other meteorological covariates was developed based on random forest algorithm. By applying this model, daily AOD dataset with 1 km resolution in 2015 was generated with complete spatial coverage. The "out-of-bag" R2 of the model averaged 0.93 with an interquartile range from 0.90 to 0.95. A random forest-based PM2.5 prediction model incorporating gap-filled AOD, land use, and meteorological terms was then developed to predict 1 km ground-level PM2.5 in 2015. Ten-fold cross-validation revealed good model performance with an R2 of 0.82. In the gap-filling model, snow fraction had a significantly higher importance in snow season of 2015. Models fitted with/without snow fraction also showed discernable PM2.5 pattern changes, further confirming the importance of this parameter. Compared to methods without explicitly considering cloud and snow cover, our PM2.5 prediction surfaces displayed more spatial details and reflected small-scale terrain-driven PM2.5 patterns. Our method can be generalized to the areas with extensive snow cover for producing reliable PM2.5 predictions with high resolution and complete coverage.

## **P01.1040. Neighborhood Scale Health Impacts from PM2.5 in Four United States Metropolitan Areas**

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**Abstract:** Background: Epidemiological cohort studies have found associations between long-term exposure to fine particulate matter (PM2.5) and increased mortality as well as associations between short-term PM2.5 and asthma exacerbation. Findings from these studies have been used to quantify health impacts due to PM2.5 and other air pollutants in the US, but have primarily used county, state, or national level disease information. Objective: The objective of this study is to evaluate health impacts of PM2.5 at a finer spatial resolution than has previously been estimated (0.01x0.01-degree), utilizing tract level disease rates and satellite-derived exposure estimates in four major US metro areas: Boston, Los Angeles, New York City, and Washington, DC. Methods: We estimated PM2.5-related asthma emergency room visits and cause specific mortality for stroke, lung cancer, and COPD using epidemiologically-derived health impact functions. Census tract level disease- and age-specific baseline incidence rates were derived using tract-level to city-level disease rate ratio scaling. Tract surveillance data and mortality rates were obtained through the CDC's 500 Cities Project and WONDER database, respectively. Relative risk estimates linking PM2.5 with health outcomes were drawn from a recent American Cancer Society study. The estimated health impacts were calculated using the environmental Benefits Mapping and Analysis Program-Community Edition v1.3 (BenMAP-CE v1.3). High resolution (0.01x0.01-degree) PM2.5 concentrations are from a global dataset integrating satellite remote sensing with chemical transport modeling and in situ observations. Results: We show computed asthma emergency room visits and cause-specific mortality attributable to PM2.5 on 0.01x0.01-degree grid in four major US cities. PM2.5-attributable health impacts vary considerably between tracts within these metropolitan areas. Neighborhoods experiencing particularly large health impacts from PM2.5 exposure are highlighted.

## **P01.1050. Syria and Yemen Wars and Their Impact on Atmospheric NO<sub>2</sub>**

Aigerim Maksot

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Abstract: Vertical Column Density (VCD) of NO<sub>2</sub> over the atmosphere of the Syrian Arab Republic and Yemen during the 2005-2016 period was studied to understand the potential impact of the war on the atmosphere of the two countries as well as their neighbour regions. The concentration data of NO<sub>2</sub> was retrieved from the satellite data collected by the Ozone Monitoring Instrument (OMI) on the board of Aura Satellite and analyzed through the NCAR Command Language and Giovanni web-based application. The current study investigated the impact of energy sector, social and geopolitical situations in the two countries on NO<sub>2</sub> concentrations before and during the war. A trend of VCDs in the aforementioned countries imply that a war has an impact on NO<sub>2</sub> concentrations, thus a thorough analysis of the dynamics of NO<sub>2</sub> concentrations over the atmospheres of countries experiencing war is of the essence. An analysis of the Syrian and Yemeni atmospheres before the war period showed a slightly increasing trend of NO<sub>2</sub>, which is a typical observation for oil-based countries experiencing the growth of the population, vehicles use, and the development of the industry. The war impact on the amount of NO<sub>2</sub> in Syria can be noticed by a sharp decrease of nitrogen dioxide from  $1.83 \times 10^{15}$  molecules/cm<sup>2</sup> till  $1.15 \times 10^{15}$  molecules/cm<sup>2</sup> when the vigorous armed interactions have begun, however, the VCD of NO<sub>2</sub> gradually increases in Yemen during the war from  $0.56 \times 10^{15}$  molecules/cm<sup>2</sup> in 2015 till  $0.66 \times 10^{15}$  molecules/cm<sup>2</sup> in 2017. The main effect of war can be explained by the considerable reduction of the population caused by refugee migration, termination of the energy sector and fossil fuel production due to disturbances in building infrastructure. Also, an important aspect of the significant number of chemical attacks and explosions during the war affect the concentration of NO<sub>2</sub>.

**P01.1060. Escape to America: Adapting European Study for Cohorts for Air Pollution Effects (ESCAPE) Methods to the Desert Southwestern U.S.**

Nathan Lothrop

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Abstract: The influence of air pollution on respiratory illnesses is well-documented, however few long-running respiratory studies have measured air pollution at participant homes or other locations. To retrospectively predict air pollution exposures, various approaches have been taken, including dispersion modeling, geostatistical interpolation, and land use regression (LUR) modeling. LUR modeling as per the European Study for Cohorts for Air Pollution Effects (ESCAPE) has been used in >30 locations in Europe, but never in the US nor validated with values measured >10 years prior. In this study, we tested the ability of LUR models to predict air pollutant measures from nearly 30 years earlier in Tucson, AZ. Using ESCAPE sampling methods, the Tucson Air Pollution Study (TAPS) sampled NO<sub>2</sub> in 40 homes and PM<sub>2.5</sub> and PM<sub>10</sub> in half of those homes for 3 two-week periods from 2015-2016 in Tucson, AZ. Using comparable sampling methods, the Pima County Workers Study (PCWS) measured NO<sub>2</sub> in 39 homes and PM<sub>2.5</sub> and PM<sub>10</sub> in 17 homes for 2 one-week periods in 1987 in Tucson, AZ. LUR models were developed for each pollutant in each dataset and internally validated with ESCAPE methods. Then, TAPS-based LUR models predicted PCWS pollutant levels. During internal validation, TAPS-based LUR models performed better than PCWS-based models: for TAPS, adjusted R<sup>2</sup> values for NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> were 0.75, 0.55, and 0.68, respectively, versus, 0.47, 0.25, and 0.21 for PCWS. In retrospective prediction, adjusted R<sup>2</sup> values (root-mean-square error) for TAPS-based LUR models for NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> were 0.37 (10.7 ppb), 0.70 (27.6 µg/m<sup>3</sup>), and 0.30 (17.3 µg/m<sup>3</sup>), respectively. While predictions for PM<sub>2.5</sub> and PM<sub>10</sub> levels had limited success, the NO<sub>2</sub> predictions were within the measured range but generally under-predicted (predicted vs. measured ranges: 2.83 - 8.41 vs. 5.17 - 24.8 ppb). Our project shows promise for using LUR to retrospectively model air pollution levels measured nearly 30 years earlier.

## **P01.1070. Spatial and Temporal Variation of Lung Deposited Surface Area at Kerbside Locations in a Metropolitan City**

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**Abstract:** Traffic related air pollution is one of the great concerns in urban areas in low- and middle-income countries. With continued efforts in reducing particulate mass concentrations, scientists have started looking into ultrafine particulates (UFPs) and its characterisation. As UFPs have larger surface area, they can deeply penetrate into respiratory tract, causing adverse health issues. A few recent studies have considered lung deposited surface area (LDSA), particle number concentration (PNC) along with black carbon (BC) and PM<sub>2.5</sub> to characterise the UFPs. The aim of this study is to examine the kerbside concentrations of UFPs and its variation with real-world driving conditions in Mumbai. Kerbside real-time measurements of LDSA, PNC, BC and PM<sub>2.5</sub> were conducted on major roads, expressway and urban background from Jun 2016 to Feb 2017 in North Central Mumbai. All measurements were done on weekdays during rush (8:00-12:00) and non-rush (12:00-16:00) hours. Near expressway, average concentration of LDSA and PNC are 351 and 26,000 #/cm<sup>3</sup>, respectively. Corresponding levels near major roads are 237 and 20,000 #/cm<sup>3</sup>, respectively. LDSA is 2.5-3.5 times and PNC is 3.5-4.5 times higher than that of background whereas for BC and PM<sub>2.5</sub> it is 2.0-3.0 times and 3.0-4.5 times higher than background. Among the pollutants LDSA and PNC show a good correlation (Spearman  $\rho=0.87$ ), while LDSA and BC illustrate a weak correlation ( $\rho=0.27$ ). The correlation is 1.2-2.5 time higher on expressways compared to the major roads. The average kerbside/background ratio of PM<sub>2.5</sub> is 1.2-1.9 times lesser than that of LDSA or PNC. These findings suggest differential impact of on-road traffic volume, driving conditions and traffic composition on the pollutants' levels and higher levels of exposure to ultrafine particulates near roads.

## **P01.1080. Relationship between Low Birthweight and Air Pollution in a Port Brazilian City**

Maura Eduarda Brandao

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**Abstract:** Santos is a seaboard Brazilian city recognized by its port activity. Because of proximity to the city of Sao Paulo, the road and rail infrastructure and the large transportation operation, there is an intense cargo handling capable of emitting all kinds of toxic and polluting waste. Some studies have pointed out the relationship between air pollution and perinatal outcomes. Pollutant gases such as CO, SO<sub>2</sub>, NO<sub>x</sub> e O<sub>3</sub> and particulate matter PM<sub>2,5</sub>, PM<sub>10</sub> have been cited as factors involved in such outcomes. Therefore, the present study aims to evaluate the association between atmospheric pollutants monitored by the São Paulo State Environmental Agency (CETESB) and perinatal outcomes in the city of Santos from January 2011 to December 2015. **METHODS:** It is a historical cohort study of pregnant women. Birth weight and information on mother and pregnancy were obtained at the Brazilian "Born Alive National Information System" (SINASC, in Portuguese). Daily records of air pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub>), temperature and relative humidity of air, for the study period, were obtained from CETESB. Associations between low birth weight and air pollutants mean levels at each gestational trimester were investigated using multiple logistic regression model controlled by the variables: maternal education, prenatal care, marital status, maternal age, anomalies, pregnancy type and number of dead children. **RESULTS:** The effects for PM<sub>2,5</sub> and PM<sub>10</sub> in the third trimester for the last quartile (19,59 µg/m<sup>3</sup> and 38,64 µg/m<sup>3</sup> respectively) were found the risk of 1,18 (CI 95% 1,01; 1,38 for PM<sub>2,5</sub> and 1,01; 1,42 for PM<sub>10</sub>). **CONCLUSION:** Although air pollution levels are lower than the other metropolitan areas in Brazil, the results show an effect on low birth weight at higher concentrations suggesting that not only burning of fossil fuels but port activity also can contribute in the emission of organic particulate matter such as soybeans, corn, wheat, etc.

## **P01.1100. Improvement of LUR Model Predictions Using Chemistry-Transport Model Estimates**

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**Abstract:** Background: In the German Ruhr area, two commonly used air pollution (AP) models are available and yield different long-term AP estimates. While the Land Use Regression (LUR) estimates point-specific AP, the EUROpean Air pollution Dispersion Chemistry Transport Model (EURAD-CTM)) represents background AP within a grid of 25km<sup>2</sup>. We combined both models by considering AP values from the EURAD-CTM as potential predictors for the LUR-model to estimate long-term AP for PM<sub>2.5</sub>, PM<sub>10</sub>, and NO<sub>2</sub>. Methods: The original LUR model was developed within the European Study of Cohorts on Air Pollution Effects (2009) using a standardized strategy to select predictors from traffic and land use predictor variables of a GIS database. For the new LUR model, we applied the same variable selection strategy, additionally including long-term AP estimates (mean PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> for 2006-2008) from the EURAD-CTM as potential predictors. Results: Original predictors for PM<sub>2.5</sub> included total heavy-duty traffic load on all roads within a 1000m buffer (heavytrafload1000), surface of industry within 5000m (industry5000), population density within 1000m (pop1000) and the x-coordinate (R<sup>2</sup>=0.85), while the new model included pop1000, CTM-PM<sub>2.5</sub>, heavy traffic major road within 1000m, industry5000 and the y-coordinate (R<sup>2</sup>=0.93). Original PM<sub>10</sub> predictors were heavytrafload1000 and pop1000 (R<sup>2</sup>=0.66), while the new PM<sub>10</sub> model included road length within 1000m, CTM-PM<sub>10</sub>, surface area of high density residential land within 5000, urban greenness within 300m and industry300 (R<sup>2</sup>=0.95). The new NO<sub>2</sub> model did not change from the original, including industry5000, pop100, surface of port within 1000m and traffic load within 100m (R<sup>2</sup>=0.88). Conclusion: Offering CTM-AP estimates as candidates changed LUR-model predictors for PM<sub>2.5</sub> and PM<sub>10</sub> and improved the model fit considerably. The agreement with actual AP measurements and the effect on health outcomes of these new LUR model has to be evaluated in future studies.

## **P01.1120. The Causal Response of Wellbeing to Air Pollution: Does the Metric of Wellbeing Matter?**

Daniel Bi

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**Abstract:** Introduction: Various wellbeing metrics adopted by researchers made it less possible to conclude the extent to which a change of wellbeing on a particular metric caused by air pollution could be generalized to another. Additionally, exiting evidences based on the data from household survey were challenged by uncontrolled confounders and limited capacity on explaining causal relationships. Methods: We creatively introduced an environmental psychological experiment paradigm to investigate the wellbeing response in different metrics to PM2.5. Images matched with varied PM2.5 as the stimulus were viewed by 110 participants in a quiet lab. E-prime 3.0 recorded participants' immediate wellbeing response in metrics of Self-Assessment Manikin (SAM) and annoyance after each stimulus. Participants are divided into four groups by whether they were told the experimental objective and whether there were landmarks in the background of pictures to examine the stigma effect of air pollution and the interference of picture background, respectively. Results and Discussion: Regarding the annoyance, critical PM2.5 were 42-50  $\mu\text{g}/\text{m}^3$ . Under critical interval PM2.5 didn't cause additional annoyance while above critical levels the annoyance increased by 1.95% per 10  $\mu\text{g}/\text{m}^3$  PM2.5 increase. Similar patterns were found in valance and arousal of SAM. The valance increased by 1.56% per 10  $\mu\text{g}/\text{m}^3$  PM2.5 increase, with a broader critical interval of 42-65  $\mu\text{g}/\text{m}^3$  where the valance shifted from positive ratings (score $\geq$ 5) to negative ones (score $<$ 5). The arousal presented a U curve with the bottom level located in 42-50  $\mu\text{g}/\text{m}^3$ . Even using different wellbeing metrics, the same findings were concluded that PM2.5 caused negative wellbeing consequences with the threshold of 42-65  $\mu\text{g}/\text{m}^3$ . Participants who were told the objective reported significantly lower valance and higher annoyance than the counterpart, which proved the stigma effect. All findings were independent from the interference of picture background.

## **P01.1130. Air Quality Changes after Hong Kong's Shipping Emission Policy: An Accountability Study**

Tonya Mason

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**Abstract:** Background: On July 1st 2015, Hong Kong became the first city in Asia to enforce a policy that regulates emissions from ships. However, adequate scientific evidence to evaluate the environmental impact of the policy is limited. Hence, we aimed to conduct an accountability study on the current shipping emission policy, assessing the improvement of ambient air quality.

**Method:** Interrupted time series (ITS) was the chosen study design. In a series of segmented regression models, pre- intervention to post intervention changes in ambient air quality at Hong Kong's major shipping port Kwai Chung (KC) were evaluated; by studying the level and slope changes in the average monthly concentration of sulfur dioxide (SO<sub>2</sub>), respirable particulate matter (RSP), nitrogen dioxide (NO<sub>2</sub>) and Ozone (O<sub>3</sub>). Regression modeling was also done on pollution concentrations recorded at a background station (Tai Po), that was defined as a control station for the study. The policy was further evaluated using cumulative sum (CUSUM) charts. Results: Our segmented regression analysis revealed a significant decline in mean monthly SO<sub>2</sub> concentration at the Kwai Chung (KC) station post policy ( $\beta_2 = -10.092$  with a  $P = 0.000401$ ). No significant concentration decrease post policy was discovered for the other pollutants (RSP, NO<sub>2</sub>, O<sub>3</sub>) or for any of the pollutants recorded from the control station, Tai Po (TP). Visually, the CUSUM charts displayed a significant decrease in sulfur dioxide (SO<sub>2</sub>) concentration (46.33%) at the Kwai Chung (KC) monitoring station post policy; and at the TP station, it showed SO<sub>2</sub> declining way before the policy was implemented. Conclusion: Enforcement of the shipping emission policy was successful at reducing SO<sub>2</sub> at Hong Kong's major shipping port KC. Our study demonstrated an efficient approach to conduct an accountability study and provides substantial evidence about the benefits of implementing marine emission policies.

## **P01.1140. Chemical Composition and Oxidative Potential Analysis of Inhalable Road Dust in Toronto**

Yuanyuan Xie

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**Abstract:** In many cities, traffic combustion emissions are decreasing as a result of more stringent emissions standards and resulting technological improvements. However, non-tailpipe emissions have been neglected and their relative contribution to total traffic-related particle emissions is expected to increase in the upcoming years. The chemical composition of non-tailpipe particulate matter has been reasonably well established. However, too little is known about the toxicity of non-tailpipe emissions and the road dust they produce. Road dust contains a mixture of particles from several sources such as road surface wear, soil, tire wear, and brake wear. It can be resuspended by wind or traffic turbulence and thereby pose a threat to public health. This presentation will focus on the relationship between inferred toxicity and the chemical composition of inhalable road dust (PM<sub>2.5</sub> and PM<sub>10</sub>) from different districts within Toronto. Road dust was collected from residential roads, highways, arterial roads, underground parking garages, ground parking area, and urban background sites. Size-resolved inhalable road dust samples were resuspended onto filters through a custom-built apparatus. The oxidative potential of PM<sub>2.5</sub> and PM<sub>10</sub> in road dust is being determined with the acellular dithiothreitol assay to infer toxicity. The metal and organic composition of PM<sub>2.5</sub> and PM<sub>10</sub> in road dust are being determined and source apportionment will be performed to link the inferred toxicity back to specific sources. This work will improve our understanding about the toxicity of non-tailpipe emissions, and also give deeper insights into the relationships between the oxidative potential of road dust, its chemical composition and its contributing sources.

## **P01.1150. Review on Ultrafine Particle Health Effects**

Simone Ohlwein

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**Abstract:** Background: Due to their small size, inhaled ultrafine particles (UFPs) may enter into alveoli and are even capable of penetrating cell membranes. Toxicological studies suggest that UFPs contribute to the development and progression of various diseases. However, epidemiological evidence for health effects of UFPs is scarce. The aim of this project is to give an overview of the epidemiological literature on the effects of UFPs on health. Methods: We conducted a systematic literature review searching MEDLINE and LUDOK data bases (time period January 2011 - May 2017) as well as a by hand search for review articles and conference proceedings. We focused on epidemiologic studies that investigated health effects of UFPs, included quantitative effect measures and had a common UFPs-measure. Data extraction and quality assessment using standard instruments was conducted by two reviewers. Results: Overall, 85 unique references were included in the review. Most of these studies were conducted in North America (n=37) or Western Europe (n=27). The majority of the studies investigated short-term effects (n=75). Ten studies investigated long-term associations. Short-term studies were dominated by panel studies with repeated measures, scripted exposure studies and time-series studies. The investigation of health effects in epidemiological studies has substantially developed during the last 7 years. Specifically, the more recent studies have undertaken efforts to control for co-pollutants in order to identify independent effects of UFPs. Despite the advances in the field, the evidence on health effects remains inconclusive or insufficient for most of the studied outcomes. Conclusions: A future challenge is the development of enhanced spatiotemporal models that are able to contribute to a more precise exposure assessment across larger areas and incorporate multipollutant models to estimate independent UFP effects.

**P01.1160. The Cardiorespiratory Impacts of Long-Term Ambient Air Pollution Exposure in China: Assigning Individual Pollutant Exposures within a Large Prospective Cohort Study**

Katherine Newell

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Abstract: Research quantifying the long-term health effects of ambient air pollution (AAP) exposure in China is scarce, limited by the need for large prospective cohorts plus assignment of individual AAP exposure. Existing studies often lack these accurate measures of individual exposure. We aimed to use spatio-temporal models to assign AAP exposure to participants within an existing prospective cohort study, the China Kadoorie Biobank (CKB). This abstract describes a pilot study using data from Suzhou, one of the 10 CKB regions. We obtained daily measurements of coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>), from 13 fixed-site monitors in Suzhou, between 2013 and 2015. We also incorporated the spatial covariates of elevation, land use, and distance to nearest motorway. We applied Bayesian modelling using the Integrated Nested Laplace Approximation (INLA) approach to predict pollutant levels for 81 assessment centres matched to 53,260 participants, each living within approximately 1km of their respective centre. Predicted AAP estimates at each centre can then be used as proxies for individual exposure in further analyses of adverse health impacts. Predicted exposures will subsequently be incorporated as time-varying covariates in Cox proportional hazards models, examining the risk of cardiorespiratory (ICD10: I00-I99/J00-J99) mortality and morbidity associated with long-term AAP exposure. We will also be able to incorporate a wide range of potential confounders provided within CKB. AAP exposure measures that we obtain on a finer temporal and spatial resolution will allow us to minimise exposure assessment bias. Combined with the high data quality of CKB and availability of numerous potential confounding variables, this research will allow us to examine cardiorespiratory health impacts of long-term AAP exposure more accurately than previous studies.

**P01.1170. Short-Term and Long-Term Exposures to Fine Particulate Matter Constituents and Health: A Systematic Review and Meta-Analysis**

Yang Yang

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**Abstract:** Background: Being a mixture of heterogeneous components, fine particulate matter (PM<sub>2.5</sub>) has been observed to pose varying magnitudes of health effects by season and region. It remains largely unknown which components were the most harmful to human health. We conducted a meta-analysis to explore the health effects of short term and long term exposures to different constituents of PM<sub>2.5</sub>. Methods: A systematic literature search was conducted to obtain relevant studies as of October 31, 2017. We applied a random-effects meta-analysis to estimate the overall health effects for each constituent. Results: Significant associations were observed between several PM<sub>2.5</sub> constituents and different health endpoints. Black carbon (BC) and organic carbon (OC) were most robustly and consistently associated with all natural and cardiovascular mortality and morbidity. Other potential toxic constituents including nitrite, sulfate, Zn, Si, Fe, Ni, V, and K were associated with cardiovascular health, and nitrite, sulfate and V were relevant for respiratory health endpoints. The results were robust when we restricted to studies with PM<sub>2.5</sub> mass being controlled. Conclusions: Our analysis suggests that BC and OC are important detrimental components of PM<sub>2.5</sub>, and other constituents are probably hazardous to human health, but more studies are warranted to further confirm their health effects.

## **P01.1190. Short-Term Effects of Fine Particulate Matter and Ozone on the Cardiac Conduction System in Patients Undergoing Cardiac Catheterization**

Siqi Zhang

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**Abstract:** Background/Aim: Air pollution-induced changes in cardiac electrophysiological properties could be a pathway linking air pollution and cardiovascular events. Yet, evidence of air pollution effects on the cardiac conduction system is incomplete. We investigated short-term effects of particulate matter  $\leq 2.5 \mu\text{m}$  in aerodynamic diameter (PM<sub>2.5</sub>) and ozone (O<sub>3</sub>) on cardiac electrical impulse propagation and repolarization as recorded in surface electrocardiograms (ECG). Methods: We analyzed repeated 12-lead ECG measurements performed on 5,819 patients between 2001 and 2012. The participants came from the Duke CATHGEN Study who underwent cardiac catheterization and resided in North Carolina, United States (NC, U.S.). Daily concentrations of PM<sub>2.5</sub> and O<sub>3</sub> at each participant's home address were predicted with hybrid air quality exposure models. We used generalized additive mixed models to investigate the associations of PM<sub>2.5</sub> and O<sub>3</sub> with the PR interval, QRS interval, heart-rate-corrected QT interval (QTc), and heart rate (HR). The temporal lag structures of the associations were examined using distributed-lag models. Results: We observed four-day lagged increases in the PR interval of 0.17% (95%CI: 0.02%-0.33%) and 0.34% (0.10%-0.57%), respectively, by interquartile increments of PM<sub>2.5</sub> (7.0  $\mu\text{g}/\text{m}^3$ ) and O<sub>3</sub> (19.4 ppb); the associations remained significant up to 7-8 days after exposure. Elevated PM<sub>2.5</sub> was also associated with increases in the QTc interval lagged by three and four days, and increases in HR lagged by one and two days. Significant effects were found on all investigated ECG parameters when analyses were restricted to exposure levels below the current U.S. National Ambient Air Quality Standards. Conclusions: In patients undergoing cardiac catheterization, short-term exposure to air pollution was associated with a delay in atrioventricular conduction and ventricular repolarization, as well as increased heart rate. This abstract does not necessarily reflect EPA policy.

## **P01.1200. Associations between Ambient and Indoor PM2.5 Exposure and Cooking Fuel on Insulin Resistance in the PURSE-HIS Cohort**

Kevin Lane

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**Abstract:** Introduction: Evidence suggests that chronic exposure to ambient PM2.5 is associated with the prevalence and incidence of Diabetes Mellitus. This relationship has not been well explored in India, where there is an increased prevalence of diabetes and elevated exposures to PM2.5. Our study assessed associations between ambient and indoor PM2.5 exposure and cooking fuel type with insulin resistance as measured by the homeostasis model assessment of insulin resistance (HOMA-IR) method, in the Population study of Urban, Rural, Semi-urban Endovascular disease and Holistic Intervention Study (PURSE-HIS) in Tamil Nadu, India. Method: HOMA-IR was assessed in 8080 randomly selected participants. Estimates of ambient PM2.5 were derived using a combination of satellite retrieved aerosol optical depth and chemical transport modelling for 2010. For a subset of the cohort (n = 430), we measured indoor PM2.5, while for the rest of the sample we used cooking fuel as a proxy for indoor PM2.5. Multivariable regression models adjusted for age, BMI, sex, smoking, cooking fuel, socio-economic status. Models were stratified by sex given the difference in residential time-activity reported for females. Result: A 10 µg/m<sup>3</sup> increase in ambient PM2.5 was significantly associated with a 0.8 mg/dl (95% CI: 0.5, 1.0) increase in HOMA-IR when adjusted for risk factors and cooking fuel. Cooking fuel type was not independently associated with HOMA-IR, but did have a significant interaction with ambient PM2.5, with higher effect on HOMA-IR in homes using solid fuels when compared to homes using LPG or a mix of fuels. A 10 µg/m<sup>3</sup> increase in indoor PM2.5 had a non-significant association with HOMA-IR in female participants (0.05 mg/dl [95%CI: -0.09, 0.19]), but no association in males. Conclusion: Ambient PM2.5 was positively associated with HOMA-IR in both males and females. Indoor PM2.5 and cooking with solid fuel was associated with HOMA-IR in females only.

## **P01.1210. Short-Term Association between Particulate Matter and Acute Atrial Fibrillation Episodes**

Marcus Dahlquist

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**Abstract:** Introduction Atrial fibrillation (AF) is an arrhythmia prevalent in approximately 1-3 % of the population and is associated with a higher risk of stroke, dementia, and mortality, as well as reduced quality of life. Air pollution may be associated with heart rhythm disturbances, but there is limited evidence regarding whether short-term changes in air pollution levels are associated with acute onset of AF episodes. Methods Nearly 9,000 randomly selected 75-year olds living in Stockholm without previously known AF were screened for AF using short-term ambulatory 1 lead ECG-measurements 2-4 times a day for 14 days. Participants with AF at the index ECG did not undergo the rest of the measurements. Screenings were carried out in 2012-2014 and 2016-2018. We used generalized estimating equations to quantify the association between 24-hour exposure of Particulate Matter <10 µm (PM10) obtained from a fixed monitoring station and risk of AF onset in all participants with AF during the screening period, adjusting for temperature and temporal factors. Only AF episodes preceded by two consecutive recordings demonstrating sinus rhythm were included in the analysis. We explored potential susceptible subgroups and effect modifiers. Results Among 218 participants with 469 AF episodes we observed non-significant associations between PM10 and risk of AF [OR 1.07 (95% CI 0.94-1.21) per 10 µg/m<sup>3</sup>]. Statistically significant associations and stronger associations were observed among women (n=106) [OR 1.20 (95% CI 1.02-1.42) per 10 µg/m<sup>3</sup>] and for participants screened during the second screening period (n=95) [OR 1.26 (95% CI 1.06-1.50) per 10 µg/m<sup>3</sup>]. We did not observe effect modification by hypertension, ischemic heart disease or congestive heart failure. Conclusion Non-significant associations between short term increases in PM10 concentrations and acute episodes of atrial fibrillation were observed. The association was more pronounced and statically significant in women.

**P01.1220. Ambient Air Pollution in Relation to Diabetes and Hemoglobin A1c Biomarker in China: A Cross-Sectional Study with Findings from National Representative Data: WHO Study on Global Ageing and Adult Health (SAGE) Wave 1**

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**Abstract:** Background: Health effects of air pollution on diabetes have been scarcely studied in developing countries. We aimed to explore the associations of long-term exposure to ambient particulate matter (PM) and NO<sub>2</sub> with diabetes prevalence and hbA1C biomarker in China. Methods: we recruited 12,116 random participants aged over 50 years from 64 cities in China as part of the WHO Study on global AGEing and adult health (SAGE) wave 1 between 2007 and 2010. For respondents who provided consent (8660), blood sample was collected then analyzed diabetes (glycosylated haemoglobin and non-fasting random blood glucose). Diabetes was defined according to the American Diabetes Association's recommendations. We calculated exposure to air pollutants using data from monitoring stations (PM with an aerodynamic diameter of 10 µm or less [PM<sub>10</sub>] and nitrogen dioxide and a spatial statistical model (PM with an aerodynamic diameter of 1 µm or less [PM<sub>1</sub>] and 2.5 µm or less [PM<sub>2.5</sub>]). We used two-level logistic regression and linear regression analyses to assess associations between exposure and outcomes, controlling for confounders. Findings Most of the studied pollutants were significantly associated with increased diabetes prevalence (eg, the adjusted odds ratios associated with an increase in IQR for PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub> and NO<sub>2</sub> were 2.05, 95% CI 1.20-3.50; 1.70, 1.01-2.87, 1.01, 0.77-1.32 and 1.25, 1.00-1.50 respectively). These air pollutants were also associated with higher concentrations of fasting glucose (0.03-0.07 mmol/L). Interpretation Long-term exposure to air pollution was associated with increased risk of diabetes in older adult Chinese population.

## **P01.1230. Air Pollution Exposure during Pregnancy, Depression/Anxiety Symptoms, and Conduct/Aggressive Problems in Children in Eight European Cohort Studies**

Monica Guxens

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**Abstract:** Background: Exposure to air pollution during pregnancy may increase several behavior problems, including depression/anxiety or conduct/aggressive problems in children, but findings have been inconsistent. We aimed to study this association in a collaborative study of eight European predominantly urban population-based birth/child cohorts, including 13,376 mother-child pairs from thirteen geographic areas. Methods: Air pollution concentrations (nitrogen dioxide (NO<sub>2</sub>) and particulate matter) during pregnancy were estimated at the pregnancy addresses by land-use regression models based on monitoring campaigns performed between 2008 and 2011. Parents assessed depression/anxiety symptoms and conduct/aggressive problems at 8-12 years of age. We combined all adjusted area-specific effect estimates using random-effects meta-analysis and multiple imputation and applied inverse probability weighting methods to correct for loss to follow-up. Results: We classified a total of 1,625 children as having depression/anxiety symptoms within the borderline/clinical range and 855 within the clinical range, whereas 1,943 children were classified as having conduct/aggressive problems within the borderline/clinical range, and 861 within the clinical range. Exposure to air pollution during pregnancy was not associated with a higher odds of depression/anxiety symptoms within the borderline/clinical range (e.g., adjusted OR 0.98, 95%CI 0.95;1.02 per 10µg/m<sup>3</sup> increase in NO<sub>2</sub>) or with a higher odds of conduct/aggressive problems within the borderline/clinical range (e.g., adjusted OR 1.01, 95%CI 0.99;1.02 per 10µg/m<sup>3</sup> increase in NO<sub>2</sub>). We observed similar associations for the symptoms/problems within the clinical range. Low to moderate heterogeneity was found between areas. Conclusions: There was no evidence for an

increase in risk of depression/anxiety symptoms or of conduct/aggressive problems with increasing prenatal air pollution levels in children aged 8-12 years.

**P01.1240. Postnatal Exposure of PM10 and Autistic Behaviours among Children: The Mothers and Children's Environmental Health (MOCEH) Study**

Jiyoung Shin

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**Abstract:** Background/Aim Environmental factors may play a role in the development of neurodevelopment and some studies have shown that ambient air pollution is associated with the autistic behaviours. The study was designed to investigate the impact of outdoor air pollution on autistic behaviours among children at 4, 5 years of age in Korea by using MOCEH cohort study's data. Methods This study is a part of the Mothers and Children's Environmental Health (MOCEH) study, a Korean multi-center prospective birth cohort study initiated in 2006. After delivery, children were followed up at 48 and 60 months of age. Average exposure level of particulate matter (PM10) were estimated using the inverse distance weighting (IDW) method from prenatal period to postnatal period. A total of 322 mother-child pairs were included. Autistic behaviours were assessed using the Social Responsiveness Scale (SRS) at 4, 5 years of age. We also examined the result stratified by sex of the children. Results The average levels of PM10 during pregnancy and 3 years of age were 54.07 $\mu\text{g}/\text{m}^3$  and 50.08 $\mu\text{g}/\text{m}^3$  each. In a multiple linear regression model, although we couldn't find significant positive relationship between exposure of PM10 in children, we found that PM10 at 3 years of age was associated with increased scores of SRS T-scores at 5 years of age in boys. ( $\beta=0.36$ , 95% confidence interval [CI]: 0.05,0.66) However, there was no significant positive association in girls. Conclusions In conclusions, postnatal exposure of PM10 is associated with the autistic behaviours, in boys at 4, 5 years of age. Further study on the other air pollutants effects to autistic behaviours in children is recommended.

## **P01.1250. Trimester-Specific Prenatal Exposure to PM2.5 and Birth Weight among Minority Populations in Puerto Rico**

Rafael Rios-McConnell

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**Abstract:** Background: While prenatal exposure to air pollutants has been associated with adverse birth outcomes, these associations are largely unstudied in minority populations. We assessed the association between trimester-specific maternal exposure to fine particulate matter (PM2.5) and birthweight (BW) in Puerto Rico for live births between 1999 and 2013. Methods: We studied 339,805 singleton births (mean gestational age: 37.9 weeks, SD: 2.9) to mothers whose mean age was 25.2 years (SD 6.0) in 37 Puerto Rican municipalities with at least 50% of their land area within 10 miles of a central regulatory air pollution monitor, from which we obtained daily PM2.5 concentrations. We included births for which gestational age was  $\geq 20$  weeks. PM2.5 exposure data were available for  $\geq 75\%$  of days in each trimester. We used a Poisson regression model with a sandwich linearized estimator of variance to estimate the association between mean exposure levels per trimester and BW, dichotomized as less than or  $\geq 2,500$  grams. We adjusted for individual and municipal-level confounders and allowed for potential clustering by municipality. Results: Median PM2.5 concentration across the study period was 7.0 micrograms/m<sup>3</sup> [interquartile range (IQR) 6.0-8.1], and 35,751 infants (10.5%) had low BW. Mothers attended  $\geq 10$  prenatal visits for 69.8% of births, 89.1% of them were Hispanic and 10.9% were black. The risk ratios associated with an IQR difference in PM2.5 concentration were 1.00 (95% CI 0.98, 1.02), 1.02 (1.00, 1.04), and 1.00 (0.98, 1.03) for trimesters 1, 2, and 3, respectively. Sensitivity analysis using ordinal logistic models that cast BW as very low, low, and normal yielded similar results: odds ratios 1.00 (0.98, 1.02), 1.02 (0.99, 1.04), and 1.01 (0.98, 1.04) for respective trimesters. Conclusion: Over 14 years in a population exposed to relatively low levels of PM2.5, second trimester exposures had the strongest association with low birth weight.

## **P01.1260. Ambient Air Pollution Exposure around Conception Increased the Risk of Miscarriage**

Zhongzheng Niu

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**Abstract:** Introduction: The impact of ambient air pollution (AAP) exposure on miscarriage is unclear. This study aims to examine AAP exposure on the risk of miscarriage and to investigate the critical window of exposure. Methods: A total of 201 women in early pregnancy (4-6 weeks) were recruited in this prospective cohort from Beijing during May 2016 to May 2017, and 178 were followed during the second and the third trimesters, and at delivery. The participants provided residential and demographic information, disease history, health habits, and occupational exposures in the baseline survey. Events of miscarriage including spontaneous abortion and embryonic loss were self-reported during the follow-up periods. AAP including particulate matter 2.5 (PM2.5), nitrogen dioxide (NO<sub>2</sub>), and ozone (O<sub>3</sub>) from the 35 monitoring stations in Beijing were collected. Land Use Regression model estimated the participants' biweekly spatial AAP exposure from 8 weeks before conception till 20 weeks after. Log-binomial regression was used to assess the association of AAP exposure with the risk of miscarriage adjusted for parental age, maternal body mass index at baseline, and history of miscarriage or abortion. Results: A total of 22 (12.4%) participants reported miscarriage during 6-20 weeks of their pregnancy. AAP exposure varied across the time period with ranges of 20.9 - 207.6 ug/m<sup>3</sup> for PM2.5, 10.7 - 109.0 ug/m<sup>3</sup> for NO<sub>2</sub>, and 11.8 - 165.7 ug/m<sup>3</sup> for O<sub>3</sub>. The risk of miscarriage was about 4 times higher (risk ratio = 3.85, 95% confidence interval: 1.13 - 13.25) in women exposed to the highest tertile of PM2.5 (Median: 74.2, Interquartile range[IQR]: 35.81) compared to women exposed to the lowest tertile of PM2.5 (Median:55.87, IQR: 4.69) during the first two weeks of pregnancy. Risk of miscarriage was not significantly associated with AAP exposures during other periods. Conclusion: Exposure to high level of PM2.5 during the first two weeks of pregnancy may increase the risk of miscarriage.

**P01.1280. Seasonal Association between Ambient Ozone and Hospital Admission for Respiratory in Hanoi, Vietnam**

Ly Luong

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**Abstract:** Background: While the level of air pollutants in Hanoi is frequently above the World Health Organization suggested level, few studies on the effects of ambient air pollution on health have been conducted in Vietnam. This study aimed to examine the effects of ozone on hospital admissions for respiratory diseases in Hanoi. Methods: Hospital admissions data were collected from three hospitals in Hanoi from January 2010 to June 2014. Air pollutants data were collected from Centre for Environmental Monitoring Portal for the same period of time. We used Generalized Linear Models and Distributed lag Linear Model to assess the association. We restricted analysis the data to two summer and winter season and grouped hospital admissions by diseases and ages. Results: Ozone was associated with the risk of admission for respiratory among group of children and all ages combined at lag 5 but not for older adults. For each increase of 10  $\mu\text{g}/\text{m}^3$  of ozone, the risk of admissions for respiratory disease at lag 5 increased 3.6% among children and 3.3% for all ages. The overall cumulative lag effects were statistically significant in both winter and summer. No significant association was found for wheeze-associated diseases in any age group. Conclusions: Ozone is a risk factor for respiratory admission, especially amongst children aged < 5 years old.

## **P01.1290. Comparative Assessment of Personal Exposure to Nitrogen Dioxide Using Land-Use Regression Modeling and Wearable Monitors**

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Abstract: While measurements and models of ambient air pollutants are often used to determine the health risks and disease burdens of exposures, the cumbersome nature of exposure measurements have limited the exploration of the relationship between ambient pollutant concentrations and personal exposure. The development of the Fresh Air wristband, a wristband housing a passive NO<sub>2</sub> sampler, allows the personal exposure of vulnerable populations to be assessed directly to evaluate exposure ambient air pollutant concentrations. The objective of this study was to compare various methods for assessing personal exposure to NO<sub>2</sub> across a cohort of children in Springfield, MA. A sampling campaign was conducted during a winter season at 40 sites characterized by differing built environments and land uses. Nitrogen dioxide was measured at each site over a five-day period using a stationary Ogawa passive sampler. NO<sub>2</sub> exposure was estimated for 40 children (aged 12-13 years) using concentrations predicted using a land use regression model and measured directly using wearable samplers. The land use regression model was developed for the city of Springfield, MA (85 km<sup>2</sup> city area), and a validation of the land use regression model will be presented. Personal NO<sub>2</sub> was measured using Ogawa samplers that were housed in a Teflon chamber mounted in a wristband, worn by the children over a five-day period (Monday to Friday). A comparison of ambient NO<sub>2</sub> concentrations predicted using the land use regression model with wristband results will be discussed in relation to demographic characteristics and mode of transport to school.

## **P01.1310. Exposure to Pet or High-Level Outdoor PM2.5 in the First Year of Life and Risk of Atopic Dermatitis at 6 to 7 Years of Age**

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**Abstract:** Objective: The prevalence of non-infectious diseases, especially allergic diseases, have been increased in Korea. The aim of this study is to find out the association between exposure to pet or high-level outdoor PM2.5 in the first year of life and atopic dermatitis at 6 to 7 years of age in Korean children. Design and subjects: Based on the International Study of Asthma and Allergies in Childhood Study (ISAAC) in Korea (2010-2011), we analysed 848 1st grade elementary school students who had available data on ISAAC questionnaires in Seoul. To rule out genetic factors, we excluded children whose parents with atopic dermatitis from our studies. Atopic dermatitis was defined in a students who had self-reported symptoms or had treatment for atopic dermatitis within the last 12 months or diagnosis by physician in lifetime. Outdoor PM 2.5 concentration was obtained through the actual measurement. The association between exposure to pet or high-level PM2.5 during the first year of birth and atopic dermatitis was analyzed by using Multiple logistic regression. We used sex, age, breast-fed level as covariates in our model. Statistical analyses were performed using R .  
Results: Among 848 participants, 349(49.3%) were boys and 255 (30.1%) children turned out to be positive for atopic dermatitis. Forty one children (5.9%) were exposed to pet within the first year of life and 24-hour mean concentration of outdoor PM2.5 within the first year of life was 32.4µg/m<sup>3</sup> . In multiple logistic regression model, we found a significant association between pet exposure and high-level exposed to PM2.5 and atopic dermatitis after adjusting for covariates (the crude odds ratio (OR) =2.22, 95%CI:0.96 - 5.17, adjusted OR =2.47 95%CI: 1.01 - 6.08). Conclusion: We found a significant association between raising pets and exposed to high-level PM2.5 and atopic dermatitis in Korean children. Further longitudinal epidemiologic study will be needed to get more strong scientific evidence of this association.

**P01.1330. Effects of Air Quality Interventions on CLRD and IHD Mortality in Seoul, Korea.**

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**Abstract:** Background In 1990s and early 2000s, air quality interventions such as reinforcement of regulation of particulate matter (PM10) and sulfur dioxide (SO<sub>2</sub>) emission/air quality standards, supplement of low-emission cars and low sulfur fuel oil were conducted in Seoul, Korea. We assessed the effect of these air quality interventions on chronic lower respiratory diseases (CLRD) and ischemic heart diseases (IHD) mortality. Methods Concentrations of PM10 and SO<sub>2</sub> and directly age-standardized mortality of CLRD (ICD10 J40-J47) and IHD (ICD10 I20-I25) were compared between two periods (1998-2002, 2003-2007). We assessed the effect of interventions with an interrupted time-series analysis assuming Poisson distribution, adjusting for smoking, the quality of health care, and respiratory epidemics. Sex-specific age-standardized mortality were also estimated. Results Average PM10 concentrations decreased by 8.3% (5.6µg/m<sup>3</sup>), and SO<sub>2</sub> by 16.1% (0.001µg/m<sup>3</sup>) between the two periods. Adjusted CLRD mortality was reduced by 26.0% (95% CI: -1.7% to 46%), IHD mortality by 9.9% (95% CI: -2% to 18%). There was no significant difference in the mortality reductions for sex. Discussion Mortality reductions in chronic lower respiratory diseases and ischemic heart diseases in Seoul suggest that air quality interventions to control particulate air pollution could decrease mortality.

**P01.1340. Household Air Pollution, Ambient PM2.5 and Hypertension: Baseline Data from a Chinese Cohort Study**

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Abstract: Few previous studies adequately considered the influences of household air pollution from various heating sources when investigating the association between hypertension and outdoor fine particulate matter (PM2.5). This study aims to address this identified research gap using baseline data collected from PURE-China. A total of 45108 participants aged 35 to 70 were recruited from 2005 to 2009. We estimate ambient PM2.5 concentration according to participants' household location. Household air pollution referred to the utilities of different primary heating sources during the cold or rainy season. Hypertension was defined as self-reported physician diagnosed or receiving BP treatment or the measurement of DBP  $\geq 90$  mmHg or SBP  $\geq 140$  mmHg at the interview. Multivariate logistic regression analyses were conducted to estimate the odds ratio and 95%CI with each 10 $\mu$ g/m<sup>3</sup> increment of PM2.5, after adjusting potential confounding factors. Further analyses were carried out according to three levels of household air pollution (i.e., unclean, clean, never using heating fuels). With each 10 $\mu$ g/m<sup>3</sup> increment of PM2.5, the OR for hypertension prevalence was 1.03(95%CI=1.04-1.14) according to the base model (i.e., adjustment of age, sex and region). After further including social economic status and disease history into the base model, the OR was 1.04(95%CI=1.02-1.06), and the effect retained almost unchanged if the household air pollution was included. Habitual use of unclean heating fuels significantly increased the risk of hypertension prevalence (OR=1.62, 95%CI=1.49-1.76, vs. clean ones). No excess risk was observed for those using the clean heating source (OR=0.96, 95%CI=0.86-1.07 vs. never using heating fuels). This study highlights that both outdoor PM2.5 and emissions from using heating fuels indoors are significant associated with increased risk of hypertension. There is a pressing need for global actions on removal the source of air pollution via particularly engineering control.

## **P01.1350. Near-Road Exposures to Traffic-Generated PM2.5, NOx and Black Carbon and the Risk of Daily Mortality: A Case-Crossover Study**

Paola Filigrana

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**Abstract:** Background: A large proportion of the US population lives and works near highways where levels of traffic-generated air pollutants are the highest. While these pollutants have been linked to adverse health, typical exposure estimates assume similar time trends across space and do not account for localized differences in traffic. Aim: We aimed to quantify associations between short-term variations in traffic-generated PM2.5, NOx and black carbon (BC) and non-accidental, cardiovascular (CVD) and respiratory mortality in near-road populations using finely resolved spatiotemporal traffic data. Methods: We conducted a time-stratified case-crossover study of non-accidental, CVD, and respiratory mortality among individuals living within 1 km of all highways in the Washington State Puget Sound. Leveraging highly resolved spatiotemporal traffic data (monitored each half-mile at 5-minutes intervals) and the Research Line source dispersion model (R-LINE), we predicted hourly concentrations of traffic-generated PM2.5, NOx and BC for each subject. We then ran conditional logistic regression models, adjusted for weather, holidays, influenza, and background PM2.5. Results: For each inter-quartile range increase in 24-hour average pollution levels, we found higher odds of respiratory mortality (PM2.5: OR: 1.01, 95%CI: 0.95-1.08, NOx: 1.02, 95%CI: 0.94-1.09, BC: 1.02, 95%CI: 0.96-1.08) and lower odds of cardiovascular mortality (PM2.5: OR: 0.97, 95%CI: 0.94-0.99; NOx: 0.96, 95%CI: 0.9-0.99, BC: 0.97, 95%CI: 0.94-1.00). For both outcomes and pollutants, we found stronger associations among residents within 300 m of a highway (PM2.5: 1.08, 95%CI: 0.98-1.19 for respiratory mortality and 0.95, 95%CI: 0.91-0.99 for cardiovascular mortality). No associations were found for non-accidental or stroke mortality. Conclusion: Short-term exposures to traffic-generated air pollution may influence the odds of mortality in near road populations, though not always in the expected direction.

**P01.1360. The Influence of Fine-Scale Spatiotemporal Variation of Traffic on Exposures to Traffic-Generated PM<sub>2.5</sub>, NO<sub>x</sub> and Black Carbon in Communities Located near Highways**

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**Abstract:** Background: Traffic varies dramatically by time and place, within and between highways. These variations likely influence the distribution of traffic-generated pollutants in nearby communities but this has not yet been well studied. Aim: We aimed to characterize the influence of spatiotemporal variations of traffic activity on traffic-generated PM<sub>2.5</sub>, NO<sub>x</sub> and black carbon (BC) in communities near highways. Methods: We leveraged traffic data available every ½ mile and 5 minutes for all highways in the Washington State Puget Sound (2009-2013) to estimate traffic-generated PM<sub>2.5</sub>, NO<sub>x</sub> and BC in nearby communities. First, we modeled hourly emission rates of PM<sub>2.5</sub>, NO<sub>x</sub> and BC for each road segment using the Motor Vehicle Emissions Simulator (MOVES). Then, we used the Research Line dispersion model (R-LINE) to predict hourly concentrations of traffic-generated PM<sub>2.5</sub>, NO<sub>x</sub> and BC at 9,829 subjects within 1 km from a highway. We aggregated modeled hourly concentrations to obtain 24-hour and annual average concentrations by pollutant. Results: Mean modeled concentrations of PM<sub>2.5</sub>, NO<sub>x</sub>, and BC generated by highway traffic were 1.6±2.2 µg/m<sup>3</sup>, 25.4±31.6 ppb, and 0.66±0.88 µg/m<sup>3</sup>, respectively. These values were highly variable over space and time with higher mean concentrations for receptors closer (<150 meters) to highways (PM<sub>2.5</sub>: 2.9±3.4 µg/m<sup>3</sup>, NO<sub>x</sub>: 44.8±48.9 ppb, BC: 1.2±1.4 µg/m<sup>3</sup>), and during morning rush hours (PM<sub>2.5</sub>: 3.1±2.5 µg/m<sup>3</sup>, NO<sub>x</sub>: 45.3±34.9 ppb, BC: 1.4±1.1 µg/m<sup>3</sup>). We also observed important spatiotemporal variability with evidence of larger between-day standard deviations (SD) for receptors <150 meters (PM<sub>2.5</sub> SD: 2.7 µg/m<sup>3</sup>, NO<sub>x</sub> SD: 37.7 ppb and BC SD: 1.1 µg/m<sup>3</sup>) as compared to receptors >150 meters of highways (PM<sub>2.5</sub> SD: 1.5, µg/m<sup>3</sup>, NO<sub>x</sub> SD: 21.9 ppb, BC SD: 0.61 µg/m<sup>3</sup>). Conclusions: This study shows that traffic air pollution from highways has strong patterns across time and space that cannot be captured by more conventional, aggregated metrics of exposure.

## **P01.1370. Studying the Effects of a Limestone Quarry on the Nearby Population's Exposure to PM**

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Abstract: The typical activity in a limestone quarry includes explosions, quarrying and passage of heavy duty-vehicles. These processes typically cause high rates particulate matter (PM) emissions. Therefore, quarries located in populated areas, may be an important cause of exposure to particulate air pollution. In order to quantify this phenomena, it is important to have a good understanding of the effects of quarries on ambient concentrations of PM. This study aims to characterize the particle emission and dispersion, caused by a limestone quarry, located about 500 meters from a populated area in central Israel. Since wind speed and direction has a great effect on the particle emission and dispersion, these two parameters were measured half-hourly measurements of solar radiation, ambient temperature and precipitation. Based on the results of the wind measurements, PM sensors were located at the expected hotspots. For control measurements, some sensors were located upwind, and next to the closest main road. The wind measurements were kept going during the PM measuring period as well. Spatiotemporal patterns of the measured PM fit well with our prior knowledge of local sources and their interactions with the meteorological parameters that were measured simultaneously. It seems that the population's exposure to PM depend heavily on the meteorological conditions and the geographic distance from the main sources, as well as the activity of these sources.

## **P01.1380. Indirect Personal Household Air Pollution Exposure Assessment for Children under 1 Year of Age Using Bluetooth Low Energy (BLE) Beacon System**

Jiawen Liao

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**Abstract:** Background: Household air pollution (HAP) generated from solid fuel combustion is associated with a large health burden in children under 1 year. However, assessing personal exposure to HAP for children is challenging, leading to uncertainties in estimating effects of a clean cookstove intervention program. Methods: We recruited 20 households cooking with open fires in Guatemala with women and children under 1 year and conducted two 24-hour PM<sub>2.5</sub> samplings before and two after a liquefied petroleum gas (LPG) stove intervention for each household. In each assessment, we measured 24-hour PM<sub>2.5</sub> levels in kitchens, sleeping rooms and outdoor patios as well as personal PM<sub>2.5</sub> exposure for 20 mothers using Enhanced Children's MicroPEM (ECM). We concurrently deployed a Bluetooth Low Energy (BLE) Beacon system to estimate the microenvironment location (kitchen, sleeping room and outdoor) for mothers and children longitudinally. PM<sub>2.5</sub> levels in the assigned microenvironments were used as indirect PM<sub>2.5</sub> estimates. We evaluated the performance of the Beacon system in predicting micro-environmental locations and personal PM<sub>2.5</sub> exposure. Results: Beacon system can predict microenvironment locations correctly over 70% of time, on average. After revising deployment strategies to reduce signal disturbance, this correct location rate increased to 80%. The mean of 24-hour Beacon-derived indirect nephelometric PM<sub>2.5</sub> exposure decreased from 110 µg/m<sup>3</sup> to 13 µg/m<sup>3</sup> for mothers and from 90 µg/m<sup>3</sup> to 9 µg/m<sup>3</sup> for children before and after the LPG intervention. The Spearman correlation coefficient between hourly indirect and direct personal PM<sub>2.5</sub> exposure for mothers was 0.92 before and 0.73 after LPG intervention. Conclusion: The BLE Beacon system can provide acceptable information of microenvironment location and estimate satisfactory personal PM<sub>2.5</sub> exposure in this LPG intervention pilot study. This novel exposure assessment method can be applied in future cookstove intervention studies.

## **P01.1381. Association of Indoor Air Pollutants and Cardiovascular Hemodynamics**

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**Abstract:** Backgrounds: Indoor air quality has been associated with human health, however, there is limited information regarding personalized indoor air pollutants and cardiovascular hemodynamics. This study aims to investigate the concurrent real-time monitoring of indoor air quality and cardiovascular function. Methods: During July-October 2017, we recruited 40 subjects from 31 family for this study. Concurrent 24-h real-time monitoring of indoor air quality and cardiovascular hemodynamics were performed for each participant. Cardiovascular hemodynamics were measured via arterial pressure waveform by a cuff sphygmomanometer using an oscillometric BP device (DynaPulse 200M, Pulse Metric Inc., San Diego, CA). Time series analysis was applied to estimate the change of cardiovascular hemodynamics for every one unit (different scales) increase of air pollutants for 40 subjects. Results: The median (IQR) concentration of 24-hour indoor air pollutants were 28.80 (23.98)  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub>, 30.47(25.03)  $\mu\text{g}/\text{m}^3$  for PM<sub>10</sub>, 0.487(0.667)  $\mu\text{g}/\text{m}^3$  for carbon monoxide (CO), and 452.0 (295.0)  $\mu\text{g}/\text{m}^3$  for carbon dioxide (CO<sub>2</sub>). Time series analysis showed for every 1  $\mu\text{g}/\text{m}^3$  increase of indoor CO exposure, cardiovascular hemodynamics would increase 1.403(0.095-2.712) and 1.397(0.081-2.712) mmHg in concurrent and lag 1h systolic blood pressure respectively. In addition, the corresponding change of cardiac output would increase by 70 (13-127) ml and 73(14-132) ml for lag 1h and lag 4h respectively. For every 100  $\mu\text{g}/\text{m}^3$  increase in indoor CO<sub>2</sub> exposure, the concurrent and lag 1h cardiac output would increase by 24.1(4.9-43.3) ml and 31(12.8-49.2) ml respectively. Conclusion: Real-time indoor air quality monitoring of CO and CO<sub>2</sub> was strongly associated with personalized 24h cardiovascular hemodynamics.

**P01.1390. Multiscale Modeling of Human Exposure to Traffic Related Air Pollution: Focus on New Jersey Industrial/Transportation Corridor**

Zhongyuan Mi

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Abstract: The New Jersey Industrial/Transportation Corridor (NJITC), connecting New York, NY; Newark, NJ; and Philadelphia, PA, is one of the busiest road networks in the world. Exposure to Traffic Related Air Pollution (TRAP) is an important health concern for people living and/or commuting within this area. A multiscale/multi-model simulation approach, utilizing observations, CMAQ (the Community Multiscale Air Quality model) and RLINE (the Research LINE-source dispersion model) is used to estimate the spatiotemporal distribution of NO<sub>x</sub> and diesel exhaust particles from on-road automobiles sources. The road network, traffic volumes and fleet composition were obtained from the Highway Performance Monitoring System (HPMS), New Jersey Department of Transportation (NJDOT) and emission factors were extracted from the MOtor Vehicle Emission Simulator (MOVES2014a). Bayesian data fusion was used to adjust model estimates employing observations from local ambient air monitoring stations. The present study utilizes information collected through the earlier Rutgers Commuter Community Cohort (RC3) study, including databases of spatio-temporal commuting trajectories and associated measured personal in-vehicle concentration profiles. The Spatio-Temporal Information System (RC3-STIS) developed for the RC3 study to provide data management, analysis, visualization and screening exposure modeling capabilities, is being utilized and extended for the present study. It is coupled with the CMAQ/RLINE simulation output, a route option optimizer (developed with Google Map API) and the Agent-Based Model of Human Exposures (ABM-HE) module within the PRoTEGE (Prioritization and Ranking of Toxic Exposures with GIS Extension) system, to support further analyses of commuting behavior and of associated exposures, under scenarios that extend beyond the situations assessed and data collected via the RC3 study.

## **P01.1400. Spatiotemporal Trends in Air Pollution and the Built Environment in Urban Areas in Chile 2002-2015**

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Abstract: Chile has undergone rapid urbanization during a three-decade period of sustained development, resulting in increased air pollution in urban areas. In developed countries, health effects of air pollution have been shown to be modified by the built environment, but few studies have been conducted in South American cities due to lack of data. Remote sensing is an underused global resource that can be used to characterize air pollution and the built environment in countries such as Chile. We performed a spatiotemporal analysis of PM<sub>2.5</sub>, greenness, nighttime lights (NTL) trends in 493 urban areas in Chile from 2002 to 2015. We used annual mean PM<sub>2.5</sub> estimates developed for the Global Burden of Disease at 1 km<sup>2</sup> resolution. Greenness was assessed using Moderate Resolution Imaging Spectroradiometer derived Normalized Difference Vegetation Index (NDVI) at 250 m<sup>2</sup> and 16-day resolution. Visible Infrared Imaging Radiometer Suite derived NTL at 500 m<sup>2</sup> and 30-day resolution was used to measure urbanization density. We compared changes in PM<sub>2.5</sub>, NDVI and NTL across the 13-year period in urban areas of Chile. We also stratified by geographical region into north, central and south zones. Annual average PM<sub>2.5</sub> and NTL increased by 10.8% (1.23 µg/m<sup>3</sup>) and 24%, respectively over the study period, while NDVI decreased by 4.2%. PM<sub>2.5</sub> and NTL were positively correlated ( $r = 0.66$ ;  $p < 0.001$ ); while NDVI was inversely correlated with PM<sub>2.5</sub> ( $r = -0.44$ ;  $p < 0.001$ ) and NTL ( $r = -0.58$ ;  $p < 0.01$ ). We found differential change rates over time by geographical region, with urban areas in the central zone having the most pronounced increases in PM<sub>2.5</sub> and NTL and fastest decrease in NDVI compared to north and south zones. We generated built environment data for urban areas in Chile using public satellite data, applying methods that can be replicated in any country. The PM<sub>2.5</sub>, greenness, and NTL databases generated are a valuable resource that can be used in urbanization studies and air pollution epidemiology.

## **P01.1420. Dust Collection Efficiency by Installing the Dust Screen in Houses**

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**Abstract:** Humans have a desire to inhale the fresh outdoor air even indoor air quality is satisfactory. When the window is opened to ventilate, air quality satisfaction maybe higher than closed even the not cleaned air is entered. The purpose of this study was to evaluate indoor air quality improvement by measuring dust collection efficiency and ventilation rate reduction by installing the dust screen. Dust screen was made by modification of insect-proof net and can collect the dust by electromagnetic force. The dust collection efficiency was performed at the laboratory level and houses. The static pressure difference and flow velocity, and PM10 concentration by direct-reading instruments were measured to compare the variation of the dust collection efficiency and the ventilation rate. The static pressure difference was 0.3 mmH<sub>2</sub>O, and the concentration of PM10 concentration was decreased by 5.81% in insect-proof net. On the other hand, when dust screens were installed, the flow velocity was reduced by 20% and the static pressure difference was 1.3 mmH<sub>2</sub>O. And the dust collection efficiency of dust screen was 74.4%. It was confirmed that the ventilation rate was reduced to about 1/4 level when the dust screen was installed. Consequently, the pressure loss due to the insect screen and dust screen was 1.0 mmH<sub>2</sub>O and 2.7 mmH<sub>2</sub>O. Also, the dust collecting efficiencies of insect-proof net and dust screen was 12.9% and 74.4% respectively. In conclusion from a health perspective, efforts should be made to reduce exposure to fine dust in the atmosphere such as installation of a dust screen.

## **P01.1430. Quantifying PM2.5 Exposure from Residential Source According to Fuel Uses in Highly Polluted Ambient Environment**

Hanbin Zhang

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**Abstract:** Background Many studies have reported residential PM2.5 concentrations in association with fuel uses. Yet it remains a challenge to identify and quantify PM2.5 from residential sources in real-time exposure datasets. Censoring algorithms, which were usually used in infiltration factor calculation, could be useful for this exercise. Methods Thirty-seven senior non-smoker participants in an urban or a rural site of Beijing have completed residential exposure monitoring for at least 43 hours, during Nov-Dec 2016 (winter) and May-Jun 2017 (summer). Residential PM2.5 was measured in subjects' bedrooms using nephelometers. Corresponding outdoor PM2.5 concentrations were measured by reference monitors. A censoring algorithm (Allen et al., 2003) was applied to select data points when a residential source of pollution was identified. The ratios between residential and outdoor (R/O ratio) PM2.5 for these subjects were compared according to their fuel use information. Results In summer, subjects who used biomass for cooking have significantly higher average R/O ratio to PM2.5 than those who used non-biomass ( $p < 0.05$ ). Mean (standard deviation [SD]) R/O ratio during summer for biomass and non-biomass users were 1.5(0.5) and 1.1(1.0). The mean (SD) residential PM2.5 concentrations during summer for biomass and non-biomass users were 49.7(34.7) and 36.7(21.4)  $\mu\text{g}/\text{m}^3$ . In winter, subjects who used solid fuel (biomass or coal) for heating have significantly higher average R/O ratio to PM2.5 than those who used alternative energy (electricity or central heating) ( $p < 0.05$ ). Mean (SD) R/O ratio during winter for solid fuel and alternative energy users were 3.2(3.6) and 1.6(1.1). The mean (SD) residential PM2.5 concentrations during winter for solid fuel and alternative energy users were 315.7(313.4) and 147.8(52.2)  $\mu\text{g}/\text{m}^3$ . Conclusions Censoring algorithms from infiltration studies can be effective in quantifying residential source of pollution, even in highly polluted ambient environments.

## **P01.1440. Household Air Pollution and Urine Metabolomics in Tibet**

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**Abstract:** Background:Evidences show that exposure to air pollution is associated with a number of adverse health outcomes. Household air pollution (HAP) from solid fuel burning is one of the most important risk factors, especially in developing countries. As part of the southwest region in China, Tibetan plateau is a pristine area with clean air quality, hence is an idea place to study the health effects of household air pollution. Method:This project addressed HAP and health issues in China by measuring personal exposure to PM<sub>2.5</sub> (n=46) and kitchen area BC concentrations (n = 8), and conducting urine metabolic profiles collected from 46 Tibetans living in three villages with ultrahigh performance liquid chromatography-mass spectrometry. Household energy use surveys (n=24) were conducted regarding demographics, cook stove usage, household fuel, cooking behaviors and life styles. Results:More than 4000 metabolites were obtained from the urine samples which were existing in each subject. In hierarchical cluster analysis, we found two principle hierarchies associated with two typical sub-populations. The metabolic profiling of these two sub-populations is correlated with villages, whereas no correlation with age and gender was found. When samples were grouped by villages, PCA analysis shows principal component one could explain close to 44% of the sample variations. Besides, around 400 unique metabolites were found in village 2. Conclusion: Urine sample analysis show that the two groups have distinctly different metabolic profiles, and this might be associated with different exposure environment. Analysis using factors such as fuels, stoves, activity that could possibly affect health effects will be conducted. Further analysis could be performed to study the association between HAP exposure and various health endpoints, with the metabolites in urine samples, such as PAHs, providing profiling for stratified analysis as well as for possible illustration of the health effects pathways.

**P01.1450. Association of Morning Distribution of Real-Time Indoor Ultrafine Particulate Matter (PM2.5) Concentrations with Daily Activity Patterns of Asthmatics in South Korea : Preliminary Study Results**

Sujung Park

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Abstract: Asthmatics may be more susceptible to ultrafine particulate matter (PM2.5), due to its large number of chemicals attached on it, compared to ordinary population. Acute exacerbations of RA can lead to such severe airway obstruction that mechanical ventilation is required as a lifesaving measure. Thus, knowing the risk factors for RA is important for minimizing both the need for emergency medical interventions and disruption of daily activities. And depending on patients' degree of symptoms, acute exposure to PM2.5 can lead to severe airway obstruction. Indoor PM2.5 may be the mixture of the influx of outside air and indoor activities. Thus, understanding of the association of indoor activity pattern and variation of indoor PM2.5 level is important. The purpose of this study was to obtain the distribution of hourly indoor PM2.5 concentration in asthmatics' houses, and to evaluate its association with their daily activity pattern. From November 2016 to November 2017, a real-time PM2.5 concentrations were measured at the livingroom of each asthmatic's house (n=30) for 3 weeks with 1 minute intervals. At the same time, self-reported daily activity patterns, i.e., hourly proportion(%) of cooking activities, were also recorded every hour over 3 weeks for each patient. The median concentration of PM2.5 at the morning cooking time (7:00 to 10:00 am) was 30.0 ug/m<sup>3</sup>. The distribution pattern of hourly proportion of cooking activities were similar to that of PM2.5 concentration level, but there was 1 or 2 hour time lag. Spearman correlation coefficient between the hourly proportion of cooking activities and the PM2.5 concentration was 0.67 and 0.65 (p=0.072 and 0.078) at child asthmatics' houses and 0.7 and 0.87 (p=0.233 and 0.058 for 8 O'clock and 9 O'clock) at adult asthmatics' houses. Our real-time monitoring results demonstrated that variation of indoor morning PM2.5 concentration level was potentially associated with indoor cooking activity patterns at home.

## **P01.1460. Estimation of Ventilation Rate in Houses Using Time-Activity Pattern and Indoor Carbon Dioxide Concentration**

Soyoeng Byeon

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Abstract: Since most people spend more than about 90% of the day in indoor environments, indoor air quality is a major setting for assessing exposure to air pollutants. Factors affecting indoor air quality are indoor pollutant generation, ventilation rate, pollutant decay rate, indoor air mixing degree, outdoor pollutant concentration and indoor space volume. Among them, the ventilation rate has many limitations on the direct measurement. Therefore, it is hard to provide a representative value. The purpose of this study suggests the average ventilation rate of Korean houses using time-activity pattern and indoor carbon dioxide (CO<sub>2</sub>) concentration. Indoor air quality model was used with the hourly indoor CO<sub>2</sub> concentration of 7,500 houses during 11 months in 2015 using sensor measurements and the time-activity pattern using data from the 2014 Time-Use Survey of about 28,000 people accessed from the Korea National Statistical Office. The CO<sub>2</sub> emission per capita in the house was assumed to be 0.22 ~ 0.33 L / min based on the previous reports. The outdoor CO<sub>2</sub> was assumed to be 400 ppm and the average volume of the house was 97.4 m<sup>3</sup> according to Statistics Korea. Using a mass balance model, the ventilation rate was calculated. Using time-activity patterns of Koreans and indoor CO<sub>2</sub> concentrations in houses, the calculated average air exchange rate was 0.56±0.14 ACH (air exchange per hour) in Korea houses. Indoor air quality can be affected by indoor sources, ventilation, decay and outdoor levels. Although technologies exist to measure these factors, direct measurement are often difficult. Specially, the ventilation rate was needed considering the outdoor contribution to house indoor. In this study, using mass balance model with measure CO<sub>2</sub> concentrations in house indoors and time-activity pattern of Koreans, the ventilation rate was estimated. The estimated average ventilation rate in houses of Korea was considered to be representative value.

**P01.1470. Indoor Air Pollutants Exposure and Determinant Factors Controlling Households Air Quality for Elderly People in Hong Kong**

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**Abstract:** This study investigated the levels and determinant factors of indoor air pollutants including fine particles (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>) and formaldehyde in 55 households exclusively for elderly at Hong Kong during summer and winter (Jul.- Sep. 2016 & Nov. 2016 - Mar. 2017). The average concentrations of PM<sub>2.5</sub>, NO<sub>2</sub> and formaldehyde were 25.3+15.0 µg/m<sup>3</sup>, 40.5+16.0 µg/m<sup>3</sup> and 26.1+22.8 µg/m<sup>3</sup> in summer; 34.2+19.0 µg/m<sup>3</sup>, 43.5+17.0 µg/m<sup>3</sup> and 15.4+4.5 µg/m<sup>3</sup> in winter, respectively. There were ~50.3% households exceeding the World Health Organization indoor air quality standard for PM<sub>2.5</sub> throughout the study, with ~40.6% and ~61.0% households in summer and winter, respectively. The determinant factors for indoor PM<sub>2.5</sub> and NO<sub>2</sub> concentrations were identified as from incense burning and cooking source. Cooking with suitable ventilation is an important factor to ease indoor pollutants concentrations. Both of PM<sub>2.5</sub> and NO<sub>2</sub> indoor concentrations showed good correlations with outdoor concentrations. Winter was observed with higher pollutants concentrations than summer except for formaldehyde concentrations. Major factors controlling indoor formaldehyde concentrations are temperature and humidity. The outcome will be useful for future indoor air quality guidelines development in Hong Kong.

## **P01.1480. Particle Generation Analysis of Squalene-Ozone Reactions**

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Abstract: Humans are continuously exposed to ozone and its by-products through ambient ozone penetration indoors. Both volatile and particulate phase by-products have been found inside homes due to the reaction of ozone with highly reactive squalene, a natural component of skin oil. Particulate phase by-products may cause respiratory and ocular irritation due to their common chemical makeup consisting of carbonyls and organic acids. This work investigates the effect of varying concentrations of ozone, squalene, reaction duration, and humidity levels on both particle number generation and particle size. Squalene was loaded onto a surface at varying concentrations of 0.25-0.76 mg/cm<sup>2</sup> and ozone was passed over the surface at concentrations between 100-700 ppb to initiate the reaction. Produced particles were analyzed with a TSI Condensation Particle Counter, a Grimm mini-WRAS aerosol spectrometer, and collected on Teflon filters for extraction and derivatization with BSTFA. Subsequent analysis and identification by GC-MS were conducted where succinic acid and levulinic acid were identified as the likely unique squalene-ozone reaction products, as well as nine other alcohols and carboxylic acids. Particles produced from pure squalene are compared to that of total skin oil and those found in an air sample collected from inside a home. Particles were found to form approximately one hour after the introduction of ozone and found to be related to the relative humidity, which is consistent with nucleation and condensation mechanisms. Given the aforementioned squalene and ozone concentrations, particle counts ranged from 200-6000 #/cc The presented work aims to investigate a reaction taking place on the surface of the skin and identify compounds people may be exposed to inside their home.

## **P01.1490. Effects of Environmental Factors on Sampling Rates of VOCs with Porous Tube-Type Passive Samplers**

Haruna Nishio

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**Abstract:** Aim: It was reported that some volatile organic compounds (VOCs) caused occupational cancers. It is necessary to measure the accurate concentrations of VOCs for preventing diseases. Although passive sampling methods for measuring VOCs are useful, they may not be accurate because sampling rates of VOCs with passive samplers are affected by various environmental factors. Our aim was to reveal the effects of environmental factors on the sampling rates. Methods: Five conditions (run 1-5) in chamber (diameter, 0.12 m; length, 5.7 m) were set according to the ISO 16107 method. Ten VOCs including cyclohexanone were selected in this study. Temperature, humidity, wind speed and VOCs concentration in the chamber were controlled and monitored in real time in order to check the accuracy and variation of conditions inside the chamber. Prior to the sampling, the conditions in the chamber were kept for about one hour, and VOCs were collected for four hours with active samplers and passive porous tube-type samplers (Carbon beads passive: CBP or Charcoal passive: PAS), simultaneously. The samples were extracted with 2 mL of carbon disulfide, and the solutions were then filtrated and analyzed by GC/MS. Results: There were no significant differences in sampling rates of each conditions for CBP or PAS. For example, results of cyclohexanone in run 1 (temperature: 25°C, humidity: 80%, wind speed: 0.1 m/s, VOCs injection rate into chamber: 10 µg/min) were as follows: CBP;  $0.215 \pm 0.010$  µg/ppmv/min, PAS;  $0.196 \pm 0.010$  µg/ppmv/min. The averages sampling rates of cyclohexanone in run 1 to run 5 were as follows: CBP;  $0.210 \pm 0.012$  µg/ppmv/min, PAS;  $0.206 \pm 0.019$  µg/ppmv/min. Conclusion: We found that sampling rates of cyclohexanone with porous tube-type passive samples were constant under the different environmental conditions operated in this study.

## **P01.1491. Examining the Relationship between Household Air Pollution and Infant Nasal Carriage**

Daniel Carrion

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**Abstract:** Background/Aim: Pneumonia, the leading cause of childhood mortality worldwide, is associated with household air pollution (HAP) exposure. Mechanisms between HAP and pneumonia are poorly understood, but the Randomized Exposure Study of Pollution Indoors and Respiratory Effects trial in Guatemala identified severe pneumonia as more likely of bacterial, rather than viral, etiology. Our research seeks to confirm relationships between HAP and infant bacterial carriage, specifically among those diagnosed with pneumonia. Methods: Data were collected through the Ghana Randomized Air Pollution Study (GRAPHS), which recruited mother-infant pairs until the child's first birthday. Improved biomass, LPG, or 3-stone (baseline) cookstoves were randomly assigned to participants. The current analysis is restricted to LPG and 3-stone arms. Carbon monoxide (CO) exposures were measured for each infant and fieldworkers conducted surveillance for pneumonia. Cases were sent for treatment and nasopharyngeal swabs. Age and sex-matched controls were swabbed. Swabs were analysed with MassTag PCR for common infections. Statistical analyses included group-wise comparisons of microbial pathogens by study arm. At study completion, the association between CO-levels and specific microbes will be analysed. Results: Preliminary analysis demonstrates participants in the 3-stone arm have higher microbial levels than the LPG intervention arm ( $p < 0.0001$ ) ( $N = 198$ ). This difference appears driven by bacterial ( $p < 0.0001$ ) rather than viral levels (non-significant) among 3-stone participants. Bacterial-level differences are consistent when stratifying by cases ( $p < 0.0001$ ) and controls ( $p = 0.0049$ ). Forthcoming analysis will assess the effects on specific microbe species. Conclusions: Findings could strengthen knowledge of pneumonia etiology. Childhood pneumonia is a grave public health concern and these data could inform public health efforts, including HAP interventions or vaccination programs.

## **P01.1492. Environmental Interventions in Primary Schools and Its Impacts on Indoor Air Quality and Student Health**

Nan Yan

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**Abstract:** Background: Deficient indoor environmental quality (IEQ) in schools could adversely affect the performance and physical health of students and teachers. Ventilation rate and particle filtration are two key factors that influence IEQ. Aims: We present the design and selected results of an intervention study conducted in two schools with 2nd to 4th grade students. We describe a number of innovative outcome measures for both academic performance and physical fitness.

**Methods:** We conducted a blinded case-crossover trial of two interventions, increased ventilation rates and advanced particle filtration, in two primary schools. The school year was divided into five periods; a baseline period and four intervention periods, during which one-half of the classrooms was the treatment group; the other half was not. In each period, we measured IEQ parameters, e.g., optical particle counts (OPC), particulate matter (PM) concentrations, air change rates, volatile organic compounds (VOCs), in four classrooms in each school. Outcome measures, obtained on 629 students, included absenteeism, curriculum-based tests in several academic areas, and the progressive aerobic capacity endurance run (PACER) tests, which measures the cardio-respiratory endurance/aerobic capacity. **Results:** Interventions altered PM concentrations but did not appear substantially change estimated ventilation rates. We found that the PACER fitness scores varied little between treatment and control groups across intervention periods, but longitudinal analyses showed several changes. The interventions did not appear to alter absenteeism. Results for the two schools differed, possibly reflecting the ability to successfully implement interventions. **Conclusions:** The study suggests the potential of intervention studies in schools for identifying strategies that benefit indoor air quality and students' physical health, and suggests the need to control for time varying factors that may influence outcomes.

**P01.1493. Associations of PM2.5 Source Concentrations with Childhood Asthma Emergency Department Visits in the U.S. State of Georgia: A Case-Crossover Study**

Mengjiao Huang

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**Abstract:** Background A novel hybrid air quality model that provides complete spatial coverage of PM2.5 source concentrations throughout the U.S. State of Georgia was used to investigate associations of air pollution sources with childhood asthma exacerbations. Objectives Estimate and compare associations of 12 PM2.5 source concentrations (i.e., contributions of emissions from motor vehicles, power plants, etc. on PM2.5 concentrations) with childhood asthma Emergency Department (ED) visits. Methods ED visits for asthma or wheezing (N=122,414) among children and adolescents (age ≤18 years) were obtained from patient claims records (in 2005 and 2007). Daily average PM2.5 concentrations from 12 sources were estimated using a hybrid chemical transport (CTM)-receptor model fused with observations from stationary monitors. In the case-crossover study, odds ratios for 3-day moving average PM2.5 concentrations were estimated using conditional logistic regression, matching on day-of-week and month, and adjusting for average temperature (3-day moving average), water vapor mixing ratio (3-day moving average), and Federal holidays. Results We observed positive associations between several PM2.5 sources and asthma ED visits. For example, per interquartile range increase in the source contribution, odds ratio estimates were 1.014 (95% CI: 1.008, 1.020) for dust; 1.029 (95% CI: 1.020, 1.039) for metals, and 1.044 (95% CI: 1.027, 1.063) for natural gas. These sources comprise 5.2%, 2.2%, and 6.5% of total PM2.5 mass, respectively. Heterogeneity in odds ratios across sources could reflect differences in the importance of sources in triggering asthma exacerbations. Because the CTM has uncertainties in the emissions and meteorology inputs and in the modeling of atmospheric processes, such conclusions are tentative. Conclusions Short-term increases in the concentrations of PM2.5 from several sources were associated with increases in childhood asthma ED visits.

**P01.1494. Using Measurements of Nitrogen Oxides from a Fixed Site and a Mobile Platform to Develop Spatially- and Temporally-Resolved Land Use Regression Models**

Laura Corlin

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**Abstract:** Background: Land use regression models can have limited temporal representativeness or spatial resolution if mobile monitoring or fixed site data are used exclusively. Our objective was to build hourly spatial and temporal nitrogen oxides (NO<sub>x</sub>) models for 2003-2015 in Boston and Chelsea (MA, USA) by combining measurements from a mobile platform and a fixed reference site.

**Methods:** NO<sub>x</sub> measurements were made with a chemiluminescence analyzer mounted in a mobile platform. Monitoring sessions (3-6 hours long) occurred on 49 days in Boston and 46 days in Chelsea between 2011 and 2015. Sessions occurred on all days of the week and in all seasons. We obtained hourly NO<sub>x</sub> measurements from a federal monitoring site in Boston. We calculated spatial factors, defined as the location-specific ratio between each 10-second mobile NO<sub>x</sub> value and the corresponding hourly mean fixed site NO<sub>x</sub> value. To model the spatial factors, we tested 43 covariates including transportation network and land use variables with data obtained from public sources. We prioritized covariates that most increased the adjusted-R<sup>2</sup> and made physical sense. We multiplied the modeled spatial factors by the fixed site hourly mean to estimate NO<sub>x</sub> at <200-m and 1-h resolution. **Results:** The models were stable with two cross validation methods. The most important predictors were distance from major roads, open space, and residential areas; presence of bus/train stops; and an interaction term for wind speed and being downwind of an airport. The models over-predicted at three validation sites, especially when concentrations were low and in places farther from major roads; however, the adjusted-R<sup>2</sup> values for hourly predictions were high (0.53-0.62) and the model captured seasonal and diurnal trends well for both study areas for 2003-2015. **Conclusion:** Our modeling approach is an efficient way to develop spatially and temporally resolved exposure estimates for use in concurrent and retrospective epidemiology studies.

## **P01.1500. Acute Associations between PM2.5 and Allergic and Nonallergic Asthma Exacerbations in Children and Adults**

Natalie Rosenquist

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**Abstract:** Introduction: Asthma results from airway inflammation and has allergic and nonallergic phenotypes. It is unknown whether susceptibility to the acute effects of air pollution differs by asthma phenotype. Methods: Associations of ambient PM2.5 concentrations with acute asthma visits (including unscheduled office, urgent care, emergency department, and hospitalization) were investigated using electronic medical records from Renown Health in Reno, the largest healthcare network in Northern Nevada. International Classification of Disease (ICD) codes were used to identify patients with at least one asthma visit (N=23,331), and to classify asthma patients by phenotype based on the presence or absence of an allergic comorbidity (atopic dermatitis, allergic rhinitis, or allergy) in their medical records (allergic N=7,744, nonallergic N=15,587). Daily mean PM2.5 and temperature were obtained from a centralized monitor. Time-stratified case-crossover analyses were conducted matching on month and day of week for the time period December 2011 - June 2017. Associations of 3-day moving average (lag 0, lag 1, lag2) PM2.5 concentrations were estimated separately by asthma phenotype and adjusted for temperature and holidays. Analyses were further stratified by age (children/adult) and gender. Results: There were 49,832 acute asthma visits over the study period (21,887 among allergic patients and 27,945 among nonallergic patients). In preliminary analysis, the odds ratio (OR) for all asthma visits combined per 10 µg/m<sup>3</sup> increase in 3-day moving average PM2.5 was 1.064 (95%CI: 1.043, 1.085). The ORs for allergic and nonallergic asthma were 1.070 (95%CI: 1.038, 1.102) and 1.060 (95%CI: 1.032, 1.088) respectively. ORs for allergic and nonallergic asthma were also similar when estimated within strata of age and gender. Conclusion: Asthma visits increased 6% per 10 µg/m<sup>3</sup> increase in 3-day moving average PM2.5. Preliminary analysis showed little evidence of heterogeneity by asthma phenotype.

**P01.1510. Effects of Exposure to Air Pollution on Hospitalization for Diseases of the Musculoskeletal System and Connective Tissue Disorders in Children and Adults Living in the City of São Paulo**

Thairis Queiroz

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Abstract: Musculoskeletal diseases (ICD 10th Revision from M00 to M25 and M40 to M99) are epidemiological relevant and economically impact the Brazilian Public Health System (SUS). The systemic diseases of connective tissue (ICD 10 th Revision from M30 to M36), although rare and affecting a low population, they are complex and multifactorial diseases, requiring complex and costly treatments for public health. Beyond well-known risk factors for these diseases, air pollutants can trigger an oxidative stress response leading to systemic inflammation. The present study aimed to evaluate the correlation between exposure to air pollutants and the possible worsening of DMSCT (Diseases of the Musculoskeletal System and Connective Tissue) in children and adults admitted to hospitals of the SUS in the State of São Paulo, from 2011 to 2016. In this ecological time series study, the effects of air pollutants on the outcomes were assessed using generalized linear Poisson regression model with an third degree polynomial distributed lag model, controlling for weather variables, seasonality and days of the week. The pollutants were within the limits of the Brazilian standards imposed during the studied period, except the O<sub>3</sub> that surpassed 296 times the state standard imposed by law. A 60,65 µg/m<sup>3</sup> increase of ozone presented an acute effect on DMSCT hospitalizations with an increase of 1.08% (IC 95%: 0,11-2,06) one day after exposure. Even though within the air quality standards, 19,26 µg/m<sup>3</sup> increases of PM<sub>10</sub> concentrations were associated with acute and delayed effects on DMSCT hospitalizations. At the same day of exposure, a 2.5% (IC 95%: 0,52-4,41) increase in hospital admissions was observed and the same effect was observed 4, 5 and 6 days after exposure. Primary and secondary pollutants were associated with DMSCT exacerbation even under air quality standards reinforcing the necessity of new parameters that minimize air pollutants adverse health effects.

## **P01.1520. Short Term Seasonal Effect of Ambient Air Pollutants and Airborne Fungal Spores on the Lung Function of School Children in Western Cape, South Africa: A Panel Study**

Toyib Olaniyan

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**Abstract:** Background: Only 3 previous epidemiological studies have investigated the combined effect of short-term ambient air pollutants and fungal spores on individual level children's lung function. These studies did not investigate respiratory effects beyond 1-day lag nor investigated interaction effects. We aimed at investigating the combined effect of short-term air pollutant and fungal spore exposure on individual level lung function of school children. Methods: A panel study was conducted incorporating testing for 2 consecutive school-weeks each in summer and winter on 553 grade-4 school children from 4 informal settlements in the Western Cape Province of South Africa. Outcomes were measured using peak flow meters obtained 3-times daily concurrently at all schools. Daily PM10 levels was available from a stationary monitor near 2 of the study areas, while daily levels of fungal spores was measured using spore traps in all 4 study areas throughout the year. The effects were analysed using single- and multi-pollutant distributed lag linear and non-linear model for lags up to 5-days. Results: Daily *Alternaria* and *Cladosporium* was significantly associated with FEV1 deficit and increased PEF intraday variability, especially in winter. The strongest adverse effect was on FEV1 (-369.34 ml, 95% CI: -650 to -87.77 ml) resulting from an overall cumulative increase of 50 spores/m<sup>3</sup> in *Cladosporium* from lag day-0 through lag day-5. There was significant interaction between PM10 and *Alternaria* on reduced FEV1 ( $p < 0.001$ ) and increased intraday-variability in PEF ( $p < 0.001$ ), including PM10 - *Cladosporium* interaction on increased intraday variability in PEF ( $p < 0.01$ ), all during winter. Conclusion: The study provides evidence that daily exposure to ambient fungal spores, *Alternaria* and *Cladosporium* results in lung function deficits especially in winter. The adverse effect on lung function by the fungal spores can occur beyond the day of exposure and is modified by ambient PM10 exposure.

## **P01.1531. Effectiveness of Liquefied Petroleum Gas Stove Ownership for Reducing Household Air Pollution Exposure during Pregnancy in Guatemala**

Laura Grajeda

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**Abstract:** Background: Household air pollution from solid fuel use has been associated with adverse birth outcomes. Efforts to reduce exposure focused on chimney stoves have had limited success, and switching to liquefied petroleum gas (LPG) fuel is a promising alternative. Moreover, estimating a person's typical exposure has been a challenge in epidemiological studies, due to temporal variability. Objectives: We aimed to estimate the effectiveness of LPG stove ownership for reducing personal exposure to fine particulate matter (PM<sub>2.5</sub>) and describe the between- and within-person variation in exposure during pregnancy. Methods: We recruited women at <20 weeks of gestation in highland Guatemala and measured 24-hour average personal PM<sub>2.5</sub> exposure three times using an impactor with a Teflon filter and a pump. We used linear mixed effects model to estimate the variance components of log PM<sub>2.5</sub>, subject-specific typical personal exposures and the exposure reduction associated with stove ownership. Results: We obtained 559 repeated measurements from 218 pregnant women. Among them, 59 (27%) owned a LPG stove and 379 (68%) owned a chimney stove at recruitment. Typical exposure was 57 µg/m<sup>3</sup> (95%CI: 49-66) and 96 µg/m<sup>3</sup> (95%CI: 87-106) for women with and without an LPG stove, respectively. After adjusting for confounders, LPG stove ownership was associated with 41% lower personal PM<sub>2.5</sub> (95%CI: 27 to 52). Intraclass correlation coefficients was 0.51 (95%CI: 0.42-0.59) overall, and for women with and without LPG stove were 0.46 (95%CI: 0.27-0.62) and 0.46 (95%CI: 0.36-0.56), respectively. Conclusions: Effectiveness of LPG stoves for personal exposure reduction in pregnant women was moderate and might depend largely on the extent of adoption. The relatively high correlation among repeated exposure measures within individuals in this setting suggests that a small number measures per individual can provide a reliable estimation of typical exposure during pregnancy.

**P01.1532. Air Quality Management Policy and Reduced Mortality Rates in Seoul Metropolitan Area: A Quasi-Experimental Study**

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**Abstract:** Background: The air quality management policy was introduced in Seoul and Incheon metropolitan cities in the Republic of Korea, from 2005 to 2014. Despite particulate matter concentrations decreasing after policy implementation, the consequent health benefits have not been evaluated. Objectives: We evaluated the effects of the air quality management policy on mortality rates in Seoul and Incheon. Methods: Using interrupted time series analysis with a generalized Poisson regression model, we compared daily average mortality rates before (baseline, 2004–2005) and after (2006–2007, 2008–2009, 2010–2011, 2012–2013) the policy implementation. To account for the long term mortality trends, we weighted daily mortality rate of Seoul and Incheon with daily mortality rate of Daejeon (another metropolitan city with no air quality management policy implemented). Results: Decline in the particulate matter concentration was greater in Seoul and Incheon than in Daejeon. After adjusting for potential confounders, there were 8% decrease in cardiovascular disease mortality rates and 10% decrease in cerebrovascular disease mortality rates in Seoul in 2012–2013 compared to the baseline period. In Incheon, an 8% reduction in cerebrovascular disease mortality rates in 2012–2013 was reported. There was no change in mortality rates due to external causes or other causes of deaths excluding cardiovascular and pulmonary disease after policy implementation. Conclusions: Our study suggests that the air quality management policy was effective in reducing mortality rates in Seoul and Incheon.

## **P01.1534. Source-Specific Contributions to Fine Particulate Matter Exposure Disparities in the United States**

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Abstract: Efficiently addressing environmental injustice in air pollution exposure requires knowledge of the predominant sources of air pollution exposure disparities. Previous studies that have linked emissions sources to environmental injustice have used proximity to the emissions source as an exposure metric, but locations of emissions sources and the spatial patterns of the resulting concentrations are often only weakly correlated. We use the year-2014 US EPA National Emissions Inventory (NEI) and the Intervention Model for Air Pollution (InMAP) to estimate fine particulate matter (PM<sub>2.5</sub>) concentrations resulting from the more than 5,000 emissions source types included in the inventory, and we quantify associated exposure disparities by race-ethnicity. Preliminary results suggest 54% of source types, representing 62% of total PM<sub>2.5</sub> exposure, result in higher average exposures for minorities as compared to whites. Overall, minorities are exposed to average concentrations 1.7  $\mu\text{g m}^{-3}$  higher than whites. Significant source groups—those that contribute at least 1% of overall exposure—disproportionately impacting minorities include residential natural gas burning, commercial cooking, and highway vehicles (average exposure for minorities is 90%, 73%, and 39% higher, respectively, than whites). Significant source groups disproportionately impacting whites include coal power generation and agriculture (average exposure for whites is 26% and 15% higher, respectively, than minorities). These results can help policy-makers direct targeted efforts to mitigate inequitable exposure to air pollution.

## **P01.1535. Association of Indoor Air Pollutants and Cardiovascular Hemodynamics**

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**Abstract:** Backgrounds: Indoor air quality has been associated with human health, however, there is limited information regarding personalized indoor air pollutants and cardiovascular hemodynamics. This study aims to investigate the concurrent real-time monitoring of indoor air quality and cardiovascular function. Methods: During July-October 2017, we recruited 40 subjects from 31 family for this study. Concurrent 24-h real-time monitoring of indoor air quality and cardiovascular hemodynamics were performed for each participant. Cardiovascular hemodynamics were measured via arterial pressure waveform by a cuff sphygmomanometer using an oscillometric BP device (DynaPulse 200M, Pulse Metric Inc., San Diego, CA). Time series analysis was applied to estimate the change of cardiovascular hemodynamics for every one unit (different scales) increase of air pollutants for 40 subjects. Results: The median (IQR) concentration of 24-hour indoor air pollutants were 28.80 (23.98)  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub>, 30.47(25.03)  $\mu\text{g}/\text{m}^3$  for PM<sub>10</sub>, 0.487(0.667)  $\mu\text{g}/\text{m}^3$  for carbon monoxide (CO), and 452.0 (295.0)  $\mu\text{g}/\text{m}^3$  for carbon dioxide (CO<sub>2</sub>). Time series analysis showed for every 1  $\mu\text{g}/\text{m}^3$  increase of indoor CO exposure, cardiovascular hemodynamics would increase 1.403(0.095-2.712) and 1.397(0.081-2.712) mmHg in concurrent and lag 1h systolic blood pressure respectively. In addition, the corresponding change of cardiac output would increase by 70 (13-127) ml and 73(14-132) ml for lag 1h and lag 4h respectively. For every 100  $\mu\text{g}/\text{m}^3$  increase in indoor CO<sub>2</sub> exposure, the concurrent and lag 1h cardiac output would increase by 24.1(4.9-43.3) ml and 31(12.8-49.2) ml respectively. Conclusion: Real-time indoor air quality monitoring of CO and CO<sub>2</sub> was strongly associated with personalized 24h cardiovascular hemodynamics.

**P01.1547. Ozone Chemistry over the Syrian Arab Republic: Impact of the War**

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Abstract: Ground ozone (O<sub>3</sub>) is a major photochemical air pollutant that has negative effects on both human health and environment, exposure to which results in the development of respiratory diseases and damage to ecosystems. Ozone does not have direct natural or anthropogenic sources of emission and its formation is accounted for the cyclic photochemical reaction between its precursors, nitrogen dioxide (NO<sub>2</sub>) and volatile organic compounds (VOC). This study investigated ozone concentration and chemistry over Syrian cities Deir ez-Zor and Aleppo between 2005 and 2016. These two cities experienced a civil war in 2011 that later on involved other countries. To identify how the trends of NO<sub>2</sub> and VOC were changed due to the war, and subsequently their effect on the ozone formation, the study was divided into two periods, before and after the war. This study was conducted by analyzing Formaldehyde-to-Nitrogen Dioxide ratio (FNR), which is considered to be the main indicator of ozone sensitivity regime. It was observed that starting the war, Aleppo, located on the west of Syria experienced a change of FNR values from the range of 0-1 to 1-2 which represents a shift in ozone sensitivity regime. The city located on the east of the country, Deir ez-Zor, did not experience a considerable change in the regime, as FNR values were maintained above 2 throughout the given period. Such different responses to the presence of the war in the cities of the same country could emphasize that the war has variant effects on the ozone chemistry over the cities due to the intensity of the war interactions and background of the cities. Lastly, it was found that changes in ozone chemistry in Syria due to the war resulted in the similar changes in ozone chemistry in the bordering countries (Turkey and Lebanon), and thus areas of these countries which are close to the borders of Syrian Arab Republic experienced ozone peaks in 2012 and 2016 due to the sharp increases of ozone in Syria itself.

## **P01.1548. Modelling Indoor PM<sub>2.5</sub> and BC in Slum Homes of Mumbai, India**

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Abstract: Slums which house >50% of the population in Mumbai city (~20 million), are mostly located in the peripheries of major traffic arteries thus facing high risk to air pollution. The objective of this paper is hence to identify the determinants of indoor PM<sub>2.5</sub> and black carbon (BC) in the slum homes and develop predictive indoor models for the same. Multivariate regression models are developed using log-transformed indoor measurements in 40 non-smoking homes and outdoor measurements at a background site in a slum in Mumbai, information on S.E.S. characteristics, building characteristics and activity patterns and publicly available data from central air monitors and geographic information system. Outdoor concentration in the slum is the crucial determinant of both indoor PM<sub>2.5</sub> and BC. Outdoor PM<sub>2.5</sub> is influenced by the proximity to all major roads (especially the internal major roads with congested traffic) whereas BC is influenced by the proximity to the major roads with significant truck traffic. Number of windows and presence of exhaust fan outlets on the wall increased the indoor PM<sub>2.5</sub>, suggesting increased infiltration of outdoor PM<sub>2.5</sub> at higher air exchange rates. Surprisingly, none of the indoor pollutant sources (cooking, incense burning etc.) have a significant impact on 24-hour PM<sub>2.5</sub> or BC. The study demonstrates that the indoor slum PM<sub>2.5</sub> levels could be reasonably estimated (adj R<sup>2</sup>=0.61, RMSE=0.24) using the publicly available ambient monitoring data, GIS based local traffic information, S.E.S. characteristics and home ventilation characteristics. The results show that outdoor pollution remains an important determinant for indoor air pollution in slums. Improving the traffic circulation along the congested inner roads of slum there by reducing local outdoor air pollution and ventilation control in homes during peak traffic hours may be feasible control options.

**P01.1549. Indoor Air Pollution and Reduced Lung Function in Biomass Exposed Women: A Cross Sectional Study in Pune District, India**

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Abstract: Indoor air pollution especially from the use of biomass fuels, remains a potentially large global health threat. The inefficient use of such fuels in poorly ventilated conditions results in high levels of indoor air pollution, most seriously affecting women and young children. The main aim of this study was to measure and compare the lung function of the women exposed in the biomass fuels and LPG fuels and relate it to the indoor emission measured using a structured questionnaire, spirometer and filter based low volume samplers respectively. This cross-sectional comparative study was conducted among the women (aged > 18 years) living in rural villages of Pune district who were not diagnosed of chronic pulmonary diseases or any other respiratory diseases and using biomass fuels or LPG for cooking for a minimum period of 5 years or more. Data collection was done from April to June 2017 in dry season. Spirometer was performed using the portable spirometer to determine the lung function over Forced expiratory volume. The primary outcome variable was forced expiratory volume in 1 second (FEV1). Secondary outcome was chronic obstruction pulmonary disease (post bronchodilator FEV1/ Forced Vital Capacity (FVC) < 70%) as defined by the Global Initiative for Obstructive Lung Disease. Potential confounders such as age, height, weight, smoking history, occupation, educational status were considered. Preliminary results showed that the lung function of the women using Biomass fuels had comparatively reduced lung function than the LPG users . The mean PM 2.5 mass concentration in the biomass user's kitchen was higher than in the LPG user's kitchen. Black carbon amount was found higher in the biomass users than LPG users . Therefore, there is an urgent need to adopt various strategies to improve indoor air quality.

## **P01.1560. Diurnal Variation of Indoor Radon Levels on Hopi Lands**

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**Abstract:** Introduction: Indoor air quality (IAQ) is essential for optimum health. To assess indoor air one needs to examine sources natural and human caused emissions in buildings. Radon is one indicator used to indicate building quality. The sources of indoor radon comes primarily from soils. In closed spaces, we find higher concentration of radon, due to lack of ventilation. It worth mention that Hopi homes lack basements. Methods: Time integrated continuous radon monitor (Sun Nuclear) was placed in nineteen homes for a 24-hour sampling period on Hopi lands during the winter season. Results: Indoor Radon concentrations varied from 0-9.5 pCi/L during the winter months. The mean concentration of radon among all houses is 1.983Ci/L. Diurnal radon concentrations are elevated between 10 p.m to 8 a.m. and decline during the day (9a.m. and 8 p.m.). Four (21%) of the homes had daily average values that exceeded action levels of Environmental Protection Agency (EPA) of 4.0 pCi/L. Discussion: There is a pattern in diurnal radon concentration associated with household ventilation patterns. During the night-time, we assume closed windows and doors leading to an accumulation of indoor radon. During the day time, ventilation reduces indoor radon levels. Homes with elevated radon concentrations suggest poor ventilation and possibly housing quality. Conclusion: The hourly results provide options in determining the type of radon reduction plans that might be recommended to families to reduce indoor radon exposure. Future analysis will include house types and location within Hopi lands.

## **P01.1570. Household Predictors of Primary Cooking Fuel Switching in Nine Low and Middle Income Countries**

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**Abstract:** Background: Cooking with dirty fuels (e.g. wood, animal dung, crop residue, coal and kerosene) is a major source of household air pollution (HAP), estimated to cause 2.6 million deaths in 2016. Over the last two decades, there have been many efforts to facilitate a switch from dirty fuels to clean fuels (e.g. electricity, liquefied petroleum gas and natural gas) among low-income households. Household factors that contribute to successful 'fuel switching' on a global scale are needed to inform future interventions targeting a change from dirty to clean fuels.

**Methods:** Household level data was obtained at baseline (~2003-2009, depending on location) and during the nine-year follow up period from the Prospective Urban and Rural Epidemiology (PURE) study. Survey data from 15,567 households, representative of adults aged 35-70 living in rural areas in nine countries in Asia, Africa and Latin America, with >10% dirty fuel use at baseline, was used to assess 'primary' cooking fuel switching. **Results:** Over half (8,059) of the households indicated a different primary cooking fuel between baseline and follow up. Nearly one-third (4,949) of households adopted a clean primary cooking fuel during follow up, while 13% (2,055) of households indicated primarily cooking with different types of dirty fuel between baseline and follow up.

Overall, increasing monthly household income and number of working members in the household were positively associated with clean fuel switching, while the total number of members living in the household had a negative association. There were large between and within-countries discrepancies in the rates of, and factors that affected, switching from dirty to clean fuels. **Conclusions:** In one of the most geographically and socioeconomically diverse longitudinal studies, there was an overall uptake of clean cooking energy households. Different household factors associated with fuel switching were identified between sub-national and national locations.

**P01.1580. Environmental Justice Aspects of PM2.5 Health Impacts from Electricity Generation in U.S. Power Markets**

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**Abstract:** INTRODUCTION Fine particulate matter (PM2.5) is considered to be the most important environmental risk factors in the global human disease burden. PM2.5 and its precursors are emitted from electricity generating units (EGUs). Environmental justice includes consideration of disproportionate impacts of air pollution by demographic group. METHODS We estimate PM2.5-related health impacts from EGUs for seven U.S. Regional Transmission Organizations (RTOs) and for each state in the contiguous U.S. Our approach uses the 2014 National Emission Inventory, the Intervention Model for Air Pollution (InMAP), and concentration-response curves from the American Cancer Society reanalysis. We investigate how health impacts vary by two demographic attributes (race; income) and for one geographic attribute (each U.S. state as a source vs receptor for PM2.5 pollution from EGU emissions). RESULTS We find "reverse EJ" for electricity generation: whites are more exposed to pollutant than non-whites nationally and within most of the US RTOs. For 36 of the 48 states in the contiguous U.S., more than half of the total premature deaths attributable to EGU PM2.5 is caused by EGU emissions in other states. Nationally, we find almost no disparity by income. The results reported here are preliminary.

**P01.1590. Environmental Justice for Criteria Air Pollutants in the United States during 1990, 2000, and 2010**

Jiawen Liu

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**Abstract:** INTRODUCTION Environmental justice (EJ) research has documented disparities in air pollution exposure among racial, ethnic, and socioeconomic groups in the United States (US) for specific pollutants, time-points, and locations. Our study analyzes air pollution exposure disparities throughout the US, for multiple pollutants and decades. METHODS We investigate racial and ethnic disparities in exposure to outdoor annual-average concentrations of five EPA criteria pollutants (nitrogen dioxide [NO<sub>2</sub>], carbon monoxide [CO], particulate matter [PM<sub>2.5</sub>, PM<sub>2.5-10</sub>, PM<sub>10</sub>], ozone, and sulfur dioxide [SO<sub>2</sub>]) for 1990, 2000, and 2010. We employ residential concentrations estimates from our own national prediction models and demographic data from the US Census. We compare population-weighted mean outdoor concentrations by race-ethnicity. RESULTS Racial and ethnic minorities generally experienced higher average air pollution concentrations than non-Hispanic whites. In 2010, on average, exposures were higher for racial and ethnic minorities than for non-Hispanic whites, by 39.5% for NO<sub>2</sub>, 12% for PM<sub>10</sub>, 9% for PM<sub>2.5</sub>, 8% for CO, and 0.7% for ozone. From 1990 to 2010, relative exposure disparities between racial and ethnic minorities and non-Hispanic whites generally decreased (with the largest reduction for CO [from 27% to 8%], but increased slightly for NO<sub>2</sub> (from 36% to 39%). Exposures varied substantially by race-ethnicity. For example, in 2010, on average, Asians and Hispanics were exposed to higher levels of PM and NO<sub>2</sub> and lower levels of SO<sub>2</sub> and ozone, compared to non-Hispanic whites. For example, Asians experienced 9.45ppb of PM<sub>2.5</sub> and 1.38ppb of SO<sub>2</sub> while non-Hispanic whites experienced 9.08ppb of PM<sub>2.5</sub> and 1.59ppb of SO<sub>2</sub>. CONCLUSIONS Racial and ethnic minorities generally experience higher concentrations of criteria pollutants than non-Hispanic whites. Exposure disparities are generally declining over time, as pollutant concentrations decrease.

## **P01.1600. Racial Residential Segregation and Airborne Fine Particulate Matter Components in the United States**

Katherine Wolf

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**Abstract: Background/Aim** Both exposure to particulate matter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) and African American racial residential segregation (RRS) in the United States (US) are associated with negative health outcomes including cardiovascular and respiratory diseases, negative birth outcomes, and death. In this study we evaluate potential associations between African American RRS and PM<sub>2.5</sub> total and component concentrations in US urban areas. **Methods** We calculated 2005-2015 average census tract concentrations of total PM<sub>2.5</sub> (n=886) and aluminum (n=276), ammonium ion (NH<sub>4</sub><sup>+</sup>) (n=213), arsenic (As) (n=276), bromine (Br) (n=274), calcium (n=276), chlorine (n=276), copper (Cu) (n=275), elemental carbon (EC) (n=201), iron (Fe) (n=276), lead (Pb) (n=276), mercury (n=162), nickel (Ni) (n=276), nitrate ion (NO<sub>3</sub><sup>-</sup>) (n=267), silicon (n=276), sodium (n=264), sodium ion (n=213), sulfate ion (SO<sub>4</sub><sup>2-</sup>) (n=277), titanium (n=276), vanadium (V) (n=276), and zinc (Zn) (n=276) using daily averages from the US Environmental Protection Agency. We used 2010 US Census data to calculate a spatial isolation (SI) index of RRS by census tract and 2008-2012 American Community Survey data to evaluate socioeconomic confounding. We used a one-way analysis of variance to evaluate differences in PM<sub>2.5</sub> total and component concentrations by SI quintile and linear models to evaluate associations between PM<sub>2.5</sub> concentrations and SI quintiles. **Preliminary Results** In preliminary analyses, concentrations of total PM<sub>2.5</sub> and As, Br, Cu, EC, Fe, Ni, NO<sub>3</sub><sup>-</sup>, Pb, SO<sub>4</sub><sup>2-</sup>, V, and Zn were higher for tracts in the highest quintile of SI than for those in the lowest. Linear models showed a 0.41- $\mu\text{g}/\text{m}^3$  increase (95% CI: 0.27, 0.54,  $p < 0.00001$ ) in total PM<sub>2.5</sub> per one-quintile increase in SI after controlling for poverty, region, educational attainment, and percent Hispanic/Latinx. **Conclusion** Results suggest that total PM<sub>2.5</sub> concentrations are higher in more segregated areas and that associations appear to vary by PM<sub>2.5</sub> composition in the US.

**P01.1610. Asthma-Related Outcomes Associated with Indoor Air Pollutants from a Survey of School Children Residing in Informal Settlement Households of the Western Cape Province of South Africa**

Toyib Olaniyan

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Abstract: The health impact of indoor air pollution in informal settlement households has not been extensively studied in South Africa. This study investigated the association between asthma and common indoor exposures in a survey of school children residing in the Western Cape Province. A total of 590 children, aged 9 - 11 years, were recruited from four informal settlements in the province. The International Study of Asthma and Allergies in Children (ISAAC) questionnaire, was administered to caregivers. Pulmonary function assessment included spirometry and fractional-exhaled nitric oxide (FeNO). Phadiatop test for atopy was done. The prevalence of doctor-diagnosed asthma was 3.4% (n=20) among whom only 50% were on treatment. The prevalence of asthma symptoms (wheezing in the past 12 months) was 12.9% and 17.6% had airway obstruction (FEV1 < lower limit of normal) while 10.2% had airway inflammation (FeNO > 35 ppb). In adjusted logistic regression models, dampness, visible mould growth, paraffin-use for cooking, and passive smoking were associated with a two-fold increased risk in upper and lower airway outcomes. The strongest association was for rhinitis (adjusted odds-ratio - aOR 3.01, 95%CI: 1.45 - 6.15). There is a need for improved diagnosis of childhood asthma and indoor air quality in informal settlement households.

**P01.1620. Indoor Air Quality in Housing and Health in Women of Agua Caliente, Poncitlán, Jalisco, México (2018)**

Kenia Gonzalez Pedraza

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**Abstract:** Background / aim: In rural areas, solid fuels such as wood are usually used to cook food. In Agua Caliente, Mexico 94% of households depend on this fuel to meet their energy needs for cooking, activity that suppose the influence on indoor air quality and the health of people. The aim of this study was to characterize the levels of particulate matter in the air of the kitchens and at the same time to know the thermal comfort index to which cooks are exposed in the home and the symptoms they perceive. Methods: It was measured in the indoor air of the kitchens the number of particles/ft<sup>3</sup> of the particles with diameter 0.3  $\mu\text{m}$ , 0.5  $\mu\text{m}$ , 1  $\mu\text{m}$ , 2.5  $\mu\text{m}$ , 5  $\mu\text{m}$  y 10  $\mu\text{m}$  issued by 30 stoves that use wood as fuel (14 traditional stoves and 16 ecological stoves), at the same time values of ambient temperature and relative humidity were taken and the home cooks were interviewed to know the symptoms that they manifest. Descriptive and statistical determinations were made to analyze emissions, thermal comfort index and symptoms. Results: The amount of particulate material/ft<sup>3</sup> for all particle sizes measured at the precautionary and danger levels for humans were found in more than 60% of the houses, the emissions of MP0.3, MP0.5, MP2.5 from ecological stoves and traditional stoves at these levels were found in more than 80% of homes, the thermal comfort index considered in caution, extreme caution and danger showed a tendency to occur in a greater percentage in homes with traditional stoves > 64% compared to 31% of homes with ecological stove at the precaution level. 93% of the women reported not having any symptoms associated with the use of the wood stove. Conclusions: The study showed that both ecological stoves and traditional stoves generate emissions of particles that are injurious to health, a situation that is not reflected in the symptoms perceived by women; the thermal comfort index showed improvement when using ecological wood stoves.

## **P01.1630. Ambient Particulate Matter and Incidence of Respiratory Infection in Children: A Time Series Analysis in Urban Bangladesh**

Allison Sherris

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**Abstract:** Exposure to fine particulate matter (PM<sub>2.5</sub>) has been linked to adverse respiratory outcomes in children. However, the impact of PM<sub>2.5</sub> on child health is poorly characterized in regions with high ambient air pollution, including South Asia. This study explores associations between short-term variation in source-specific ambient PM<sub>2.5</sub> and incidence of respiratory infection among children in urban Dhaka, Bangladesh. We leverage data from health surveillance of around 5,000 children and infants between 2005 and 2014, including daily counts of physician-confirmed diagnoses from clinic visits. In addition, biweekly source-apportioned ambient PM<sub>2.5</sub> measurements were obtained for the same period. Using Poisson regression adjusted for time-varying covariates, we estimate associations between ambient PM<sub>2.5</sub> and respiratory infection at time lags of zero to seven days. We find that PM<sub>2.5</sub> exposure is associated with an increase in respiratory-related clinic visits at a time lag of two days, and that this association may be driven by increased incidence of lower respiratory infection. For example, a 10 µg/m<sup>3</sup> increase in two-day lagged ambient PM<sub>2.5</sub> is associated with a 5.1% increase in pneumonia incidence (95% confidence interval = 1.9 - 8.5). The same variation in total PM<sub>2.5</sub> was associated with a smaller and nonsignificant increase in upper respiratory infection (URI). Analysis of source-apportioned fine PM indicate that secondary sulfate and the factor attributable to zinc and plastics recycling are most strongly associated with incidence of pneumonia and URI. Results suggest that PM<sub>2.5</sub> exacerbates respiratory infections in children, and that ambient air pollution contributes to the high incidence of pneumonia in urban Dhaka.

## **P01.1640. Preliminary Assessment of Indoor PM2.5 Concentrations in Households on Hopi Lands**

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**Abstract:** Introduction: Household reliance on biomass and solid fuels has resulted in an estimated 4.3 million pre-mature annual deaths globally. Despite the prevalent use in developing nations, recent studies suggest that low income rural populations of the United States, and other affluent countries, may experience similar exposures to HAPs due to incomplete combustion of fuels indoors. Methods: Indoor 24-hour PM2.5 concentration was measured during 2 winter heating seasons (2017 & 2018) and 1 summer non-heating season (2017) using real-time area monitors (pDR-1500) set at 1-minute logging intervals. Average 24-hour indoor PM2.5 concentration was compared across household primary heating fuel type during heating and non-heating seasons. Results: To date, 26 homes have been sampled during the heating season, of which 11 have complete follow-up data during the non-heating season. Indoor mean (SD) PM2.5 concentration in all households was 30.0 µg/m<sup>3</sup> (120.8), and was 40.3 µg/m<sup>3</sup> (145.8) during heating seasons and 9.9 µg/m<sup>3</sup> (30.1) during the non-heating season. Coal-wood burning homes had indoor PM2.5 concentration of 57.9 µg/m<sup>3</sup> (185.8) during heating (n=9) and 8.4 µg/m<sup>3</sup> (19.3) during non-heating season (n=6). During the burning season, electrically heated (5.3 µg/m<sup>3</sup> (5.8)) and electric-natural gas heated (9.9 µg/m<sup>3</sup> (9.4)) homes had the lowest 24-hour concentration compared to homes that burned a combination of wood, coal & electricity (42.1 µg/m<sup>3</sup> (156.8)), and coal, wood & natural gas (49.3 µg/m<sup>3</sup> (111.3)) for heating. Discussion: Households that primarily burn wood and coal for heat had elevated indoor PM2.5 concentrations compared to homes heated with other fuel types. Even in homes using a combination of natural gas and electricity with wood and coal, indoor levels exceeded the EPA 24-hour ambient standard of 35 µg/m<sup>3</sup>. This project will continue to monitor indoor air quality and recruit households on the Hopi Lands.

## **P01.1650. Spatiotemporal Patterns of Critically Ill Small Newborns and Industrial Air Pollutants**

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**Abstract:** Introduction: Critically ill small newborns are those who are admitted to neonatal intensive care units and have a birthweight below the 10th percentile for gestational age and sex according to Canadian normative data. These are life-threatening and costly events requiring further understanding of risk factors. We assessed spatiotemporal hot spots of critically ill small newborns and industrial air emissions, an infrequently studied source of shared exposures. Methods: Using neonatal admission data of participating NICUs in the Canadian Neonatal Network from 2006-2010, we aggregated residential postal codes from nineteen census metropolitan areas (CMA) into space-time cubes and applied emerging hot spot analyses. Using National Pollutant Release Inventory data and Environment Canada weather station data, we modelled monthly dispersion of air emissions and input the results into the analyses. We compared: (i) the resulting categorical patterns using Spearman's correlation; and (ii) binary patterns using logistic regression, with industrial land use, low socioeconomic status, and the total number of 0-4-year olds for the entire study period as covariates. Results: Fifty-two pollutants exhibited statistically significant associations with small newborn hot spots. Positive correlations of hot spots were observed with three different pollutants ( $\rho > 0.4$ ,  $p < 0.05$ ) in Winnipeg, Kingston, and Vancouver, with 22 different pollutants (beta range 0.29-1.10,  $p < 0.05$ ) in the combined nineteen CMAs, and with up to 32 emissions in eight individual CMAs. The 9 most significant pollutants were Methanol, Ethylbenzene, Toluene, Styrene, Xylene, Acenaphthylene, Isopropyl alcohol, Methyl ethyl ketone, and Nickel. Conclusion: Hot spot patterns differed among CMAs. Air pollutant emissions were geographically specific and may help explain the space-time trends of critically ill small newborns.

## **P01.1670. Traffic Air Pollution and Respiratory Health Effects: A Cross-Sectional Study among Bus Drivers in Dakar, Senegal**

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**Abstract:** Introduction Traffic-related air pollution has been well documented to be associated with increased risks of airway diseases. Bus drivers are exposed to hazards resulting from the inhalation of pollutants from traffic. This study was designed to describe the frequency of chronic respiratory symptoms and illnesses as well as its related factors and to assess lung functions among bus drivers. **Methods** This was a cross-sectional study conducted among the bus drivers in HLM, Medina, and Petersen districts, Dakar, Senegal. A total of 178 adult men were assessed using a questionnaire inquiring about socio-demographic, respiratory symptoms, toxicological medical evaluation, and lung function tests. Logistic regression analysis was done to determine the relationship between various socio-demographic, occupational factors, respiratory symptoms and the respiratory diseases (chronic obstructive pulmonary disease and asthma). **Results** The results of the study show that 57.9% of bus drivers had a chronic cough, 65.7% had common cold and 53.4% had recurrent headaches. A predominance of these abnormal symptoms was noted in bus drivers located in the HLM district. Lung function tests showed that 38.8% of bus drivers had asthma and 30.3% of COPD. Multivariate analysis found that frequent cold increased the risk of having asthma (OR = 6.3, 95% CI: 1.12-35.79, p = 0.03) and COPD (OR = 7.7, 95 % CI: 1.14-52.8, p = 0.03). The respiratory health status of bus drivers depends on the work area (OR = 3.2, 95% CI: 1.13-9.31, p = 0.02). **Conclusion** Chronic exposure to air pollution from traffic is associated with respiratory symptoms and diseases and reduced lung function indices among bus drivers. **Keywords:** Air pollution, Bus drivers, Senegal, Asthma, COPD.

## **P01.1680. Characterisation of Fine Particulates in Different Commute Modes in Mumbai**

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**Abstract:** The growth of urban population leads to an increase in travel demand which in turn aggravates urban air pollution as well. A number of studies have assessed in-cabin particulate levels in different commute modes but its chemical composition is not well studied. Moreover, there is a dearth of such studies in cities in low and middle-income countries. The aim of this study is to quantify black carbon (BC) and fine particulate matter (PM<sub>2.5</sub>) and its chemical constituents in different commute modes in Mumbai. Additionally, we aim to estimate the population attributable exposure to traffic-related air pollutants due to commute in Mumbai. PM<sub>2.5</sub> (real-time and gravimetric) and BC are measured in buses (AC and non-AC), Non-AC City trains, taxis, auto-rickshaws and motorbikes. Measurements are done on weekdays during morning rush (8:00-11:00) afternoon non-rush (13:00-16:00) and evening rush (18:00-21:00) hours from Nov 2017 to Apr 2018. A minimum of 6 commute trips are made in each transportation mode travelling a fixed route (~9 Km) with a concurrent measurement at a fixed urban background location. PM<sub>2.5</sub> and BC are 1.4 and 1.6 times higher during traffic rush hours than the non-rush hours, respectively. The mean  $\pm$ SD concentration of PM<sub>2.5</sub> inside non-AC buses, AC buses, city trains, taxis, auto-rickshaws and motorbikes are  $126 \pm 16 \mu\text{g}/\text{m}^3$ ,  $55 \pm 23 \mu\text{g}/\text{m}^3$ ,  $242 \pm 8 \mu\text{g}/\text{m}^3$ ,  $122 \pm 20 \mu\text{g}/\text{m}^3$ ,  $138 \pm 14 \mu\text{g}/\text{m}^3$  and  $142 \pm 17 \mu\text{g}/\text{m}^3$ , respectively. Corresponding BC levels are  $43 \pm 6 \mu\text{g}/\text{m}^3$ ,  $11 \pm 3 \mu\text{g}/\text{m}^3$ ,  $28 \pm 8 \mu\text{g}/\text{m}^3$ ,  $38 \pm 5 \mu\text{g}/\text{m}^3$ ,  $49 \pm 11 \mu\text{g}/\text{m}^3$  and  $55 \pm 7 \mu\text{g}/\text{m}^3$ , respectively. City trains have ~2 times higher levels than other modes. Non-AC buses have similar concentrations as taxis, autos and motorbikes but ~3-4 times higher in-cabin pollutants levels than the AC buses, indicating efficient filtration of the on-road exhaust particles. Effect of road traffic characteristics on vehicular in-cabin pollutants' levels and chemical characterization of PM<sub>2.5</sub> are currently underway.

**P01.1690. Particulate Matter and Black Carbon Personal Exposure Reductions from an LPG Stove Intervention in Rural Households in Puno, Peru: Preliminary Results**

Magdalena Fandiño Del Rio

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Abstract: Household air pollution (HAP) from biomass fuels is a leading risk factor for preventable diseases and among the largest environmental contributor to the global disease burden. Previous interventions show limited results with concentrations that remain significantly higher than recommended guidelines and therefore show limited results in improving health. As a result, recent efforts are focusing on stoves that use cleaner fuels such as liquefied petroleum gas (LPG). A randomized controlled field trial of an LPG stove intervention is enrolling 180 female participants and will follow them for one year. Free LPG stoves and fuel are being delivered to 90 participants. We are collecting 48-hour measurements of personal exposure to fine particulate matter (PM<sub>2.5</sub>) and black carbon (BC). Preliminary data shows baseline daily average personal PM<sub>2.5</sub> exposures of 120 µg/m<sup>3</sup> among biomass fuel users (n=70). We observed preliminary reductions of about 80% and 78% on average personal exposure to PM<sub>2.5</sub> after the first and third month of LPG stove use respectively, compared to baseline concentrations (n=20). Personal BC exposures of about 40 µg/m<sup>3</sup> were reduced by 90% after one and three months of LPG stove use (n=25). Preliminary results show not only sharp exposure reductions expected from good compliance after one month, but also sustained reductions from the LPG stove use after three months of the intervention. Results from this analysis will provide valuable information to help understand PM and BC exposure from biomass fuel use. In addition, findings from this study will help us better understand the HAP changes that follow the adoption of LPG stoves. Results of this trial will inform the feasibility of an LPG stove replacement program to reduce HAP and improve health in resource-limited settings such as Peru.

## **P01.1700. Modeling the Impact of Indoor Air Purifier on Air Pollution Exposure Reduction and Associated Health Benefits in Urban Delhi Households**

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**Abstract:** Background: Households in urban Delhi experience elevated level of ambient and indoor air pollution. Indoor air filtration is recommended as a measure to improve indoor air quality, yet few studies have examined the effectiveness of air filtration devices in urban settings in low- and middle-income countries. This study aims to quantify the impact of household air purifier on indoor air quality and its health implications. Methods: We used CONTAM 3.2 (National Institute of Standard Technology) to simulate the indoor personal PM<sub>2.5</sub> exposure of the primary cook over 12 months in a typical one-bedroom apartment in urban Delhi. We conducted a factorial design to model PM<sub>2.5</sub> exposure as a function of air filter type (low, medium efficiency and HEPA filter), use schedule (8 hour, 15 hour and all day) and presence of another smoker. Based on the simulated exposure reduction, we employed the Household Air Pollution Intervention Tool (HAPIT) to estimate the corresponding health benefits on major conditions. All model inputs were extracted from governmental/scientific literature. Results: The modeled annual personal PM<sub>2.5</sub> exposure without air purifier was 111  $\mu\text{g}/\text{m}^3$  and 145  $\mu\text{g}/\text{m}^3$  for households without and with a smoker, respectively. The highest exposure reduction occurred in scenarios with all-day use of air purifier equipped with HEPA filter. The annual personal PM<sub>2.5</sub> level was reduced to 33 and 34  $\mu\text{g}/\text{m}^3$  for households without and with a smoker. These PM<sub>2.5</sub> reductions represent 48 and 43 deaths averted per 100,000 population per year. Simulated annual personal exposures to PM<sub>2.5</sub> from 8-hour and 15-hour use of air purifier all exceeded the WHO interim guideline at 35  $\mu\text{g}/\text{m}^3$ , mainly due to the infiltration of ambient air pollution. Conclusions: Our simulation shows that consistent use of household air purifier can reduce indoor air pollution in a city like Delhi. The reduced personal indoor air pollution exposure from air filtration can result in significant health benefits.

## **P01.1710. Liquefied Petroleum Gas as a Clean Cooking Fuel: Adoption and Use in Rural India**

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**Abstract:** **BACKGROUND:** One million premature deaths in India can be attributed to household air pollution (HAP) from the combustion of solid fuels for cooking. In response, the Indian government has developed policies to increase adoption of liquefied petroleum gas (LPG) in rural Indian households, aiming for adoption in 80% of households by 2019. Indeed, LPG is the most popular clean cooking fuel in rural India, but how rural households use it remains poorly understood. Importantly, exclusive use of clean cooking fuels is needed to reduce health risks from HAP exposure. **METHODS:** We employ the 2014-2015 Access to Clean Cooking Energy and Electricity household survey (N=8,568) from six energy-poor states to describe LPG in rural India, outlining: (i) reasons for LPG non-adoption; (ii) fuel stacking and specific dishes cooked with LPG; and (iii) cooking satisfaction and fuel perceptions. **RESULTS:** Both LPG stove (N=6376) and fuel (N=5907) costs were common reasons for LPG non-adoption (N=6712). Fewer than 60% of LPG users considered it their primary fuel, and exclusive use was rare (N=386). The remaining 40% mostly used LPG to prepare tea and snacks. While satisfaction with LPG was high (78%), three-quarters of households using LPG as a supplemental fuel cite fuel costs as a reason for dissatisfaction. For these households, the cost of one 15 kg LPG cylinder accounted for 10% of total monthly expenditures. **CONCLUSIONS:** LPG was popular among users, but fuel costs limited exclusive use. As observed elsewhere, study households likely ration LPG use by avoiding fuel-intensive dishes, limiting cooking primarily to tea and snacks. While LPG use offers great promise in rural India and numerous policy initiatives promote adoption, limited fuel affordability promotes continued woodfuel use, potentially limiting the health benefits obtained through LPG programs that focus primarily on promoting adoption.

**P01.1721. An Evaluation of Speciated Plasma Arsenicals as Potential Biomarkers of Arsenic Exposure and Arsenic-Associated Diabetes in Individuals Living in Zimapan and Lagunera, Mexico**

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**Abstract:** Background: Exposure to inorganic arsenic (iAs) remains a public health issue. Typically, three major forms of arsenic are measured in urine as biomarkers of iAs exposure, namely, iAs, and its metabolites, monomethylated arsenic (MMAs) and dimethylated arsenic (DMAs). This study is among the first to examine speciated plasma arsenicals as biomarkers of iAs exposure and iAs-associated disease, namely, diabetes mellitus (DM). Methods: Drinking water and plasma samples were collected from participants in the Zimapan and Lagunera cohort (N = 258). The relationships between drinking water iAs and plasma arsenicals were examined using both spearman correlations and multivariable linear regression models. Multivariable linear and logistic regression models were used to estimate the mean difference (95% CI) for the relationship between plasma arsenicals and diabetes indicators and the odds ratio (95% CI) for the relationship between plasma arsenicals and DM. Results: Plasma arsenicals were associated with drinking water iAs, with spearman correlation coefficients of 0.45 for P-MMAs, 0.48 for P-DMAs and 0.41 for total arsenic (P-tAs;  $p < 0.0001$ ). After adjusting for potential confounders, there were significant associations between log-transformed plasma arsenic and log-transformed diabetes indicators. Specifically, an interquartile range (IQR) increase in P-iAs was associated with fasting plasma insulin (0.089 (95% CI: 0.025, 0.153)), insulin resistance (HOMA-IR; 0.084 (95% CI: 0.017, 0.152)), and beta cell function (HOMA-B; 0.133 (95% CI: 0.007, 0.259)). Plasma arsenicals were not associated with the odds of DM. Conclusions: Speciated plasma arsenicals were associated with drinking water iAs, suggesting that they may serve as biomarkers of iAs exposure. Increases in fasting plasma insulin, HOMA-IR, and HOMA-B in the absence of changes in glycemia, indicate that plasma arsenic may be related to subclinical changes in pancreatic beta cell function that underlie DM development.

## **P01.1730. Exposure to Arsenic in Yellowknife, Northwest Territories, Canada**

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Abstract: Giant Mine, located in Yellowknife, Northwest Territories, is regarded as one of the most contaminated sites in Canada. Gold extraction from arsenopyrite ores left behind a legacy of 237,000 tonnes of arsenic trioxide stored in the inactive mine's underground chambers. Contamination of such scale is of public health concern due to the potential hazard of arsenic and other chemical exposures to the Yellowknife population as well as the local Indigenous communities: Yellowknives Dene First Nation and members of the North Slave Métis Alliance. The objective of this study is to investigate arsenic exposure in the human population of Yellowknife using a biomonitoring approach with a longitudinal cohort design. We postulate that exposure levels in the Yellowknife population are similar to that of the Canadian population, resulting in no observable effects. A community-participatory approach is used for the development of the study design. Consultations with local stakeholders started in 2016 leading to the establishment of an Advisory Committee that oversees all aspects of the study. Baseline data are to be collected from 10% of Yellowknife households through random selection, representative of the population, and volunteer participants from the Indigenous communities from 2017-2018. Urine, toenail and saliva samples are being collected from about 2000 participants ranging from 3 to 79 years old. Total and arsenic species concentrations in urine and toenails are measured using LC-ICP-MS, and compared to the data reported by the Canadian Health Measures Survey. Saliva samples are collected for the analysis of 89 single nucleotide polymorphisms of genes related to arsenic metabolism. Two protein biomarkers CC16 and KIM-1 in urine samples will be measured as biomarkers for kidney and lung functions. Our research is the first comprehensive biomonitoring and health survey conducted in the area of this major contaminated site in Canada.

## **P01.1740. Incorporating Unique Exposure Pathways of the Diné People into a Community-Based Probabilistic Risk Assessment to Assess the Impacts of the Gold King Mine Spill**

Yoshira Van Horne

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Abstract: On August 5th 2015, the Gold King Mine Spill released 3 million gallons of acid mine drainage-containing arsenic (As) and lead (Pb) into a tributary of the San Juan River, which flows through the Navajo Nation. The Diné (Navajo) rely on this River and use it for a variety of purposes lending to unique exposure pathways. We administered questionnaires in three Navajo communities in collaboration with the Navajo Nation Community Health Representatives to obtain frequency and duration data on 42 activities. These activities were utilized to conduct a community-based probabilistic risk assessment from exposure to As and Pb: 1) before the Spill, 2) during peak of the Spill, and 3) one year after the Spill. To estimate exposure to As and Pb before the Spill, we utilized historical surface water (n=32) and sediment data (n=20) obtained from the USGS. Estimation of exposure to As during peak Spill incorporated As and Pb surface water (n= 92) and sediment (n=75) concentrations obtained from U.S. EPA publically available data. To estimate exposure to As and Pb one year after the Spill, we collected surface water (n=101) and sediment samples (n=127) in these three Navajo communities within one year after the Spill. Surface water concentrations of As and Pb were significantly different between periods (p-value <0.0001), with concentrations highest during the peak of the Spill, followed by pre-Spill and post-Spill levels. Sediment concentrations were significantly different (p-value <0.0001), but with concentrations highest before the Spill, followed by peak-Spill, and post-Spill. The risk assessment for arsenic and lead through these unique water/sediment pathways indicate both potential chronic and carcinogenic risks to the local Diné community. This research provides the first documentation of unique exposure pathways of the Diné people and raise the need to understand and document unique exposure pathways of indigenous communities with subsistence and land-based livelihoods.

**P01.1750. Does Exposure to Organophosphate Pesticides Modify the Association of Low Neighborhood Socioeconomic Position with Greater Cognitive Decline?**

Kristina Dang

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Abstract: Adverse cognitive effects of social exposures such as neighborhood socioeconomic position (NSEP) may be exacerbated by environmental neurotoxins, including organophosphate pesticides (OP). Mexican-Americans are differentially exposed to both low NSEP and high OP. We examined synergistic associations of NSEP and OP on cognitive decline in older Mexican-Americans. The Sacramento Area Latino Study on Aging (SALSA, N=1,789 with cognitive assessments and N=430 with OP assessments), a cohort of Mexican Americans aged 60-100 who completed a modified Mini-Mental State Exam (3MS) annually from 1997 to 2008. 3MS errors were log-transformed. Total OP pesticide exposure from California Pesticide Use Reports was dichotomized at the median. Baseline NSEP was a composite of six census tract measures from the 2000 Census (Z-scored). We used multilevel linear mixed models with random intercepts for census tract and participant to estimate effects of NSEP and OP pesticide exposure on 3MS decline. We tested for interactions of NSEP and OP pesticide exposure. Models were adjusted for baseline age, gender, diabetes, baseline BMI, rural/urban residence, occupation, years of schooling, and practice effect. In the full sample, higher NSEP predicted better 3MS (B=-0.07 95% CI:-0.10 to -0.03), but not 3MS decline (B=0.004 95% CI:-0.002 to 0.01). OP pesticide exposure was not associated with 3MS scores (B=-0.18, CI:-0.37 to 0.015), and did not predict decline (B=0.03 95% CI:-0.006 to 0.06). For those exposed to OP pesticides, each unit increase in NSEP was associated with 0.09 (CI: -0.15 to 0.32) better 3MS, compared to 0.08 (CI: -0.14 to 0.01) worse 3MS for people not exposed to OP pesticides, but these differences may have been due to chance (p=0.273 for the interaction). Higher NSEP predicted better cognitive scores, and higher OP pesticide exposure was associated with cognitive decline. We found little evidence for a qualitative interaction between NSEP and OP.

## **P01.1760. Low-Moderate Arsenic Exposure and Respiratory Health in American Indian Communities**

Martha Powers

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**Abstract:** Background: Exposure to inorganic arsenic through drinking water is an established cause of lung cancer. However, evidence on the impact of arsenic exposure on non-malignant lung disease is less conclusive. The available evidence, mostly from populations exposed to water arsenic levels >100 µg/L, suggests that arsenic exposure is associated with lower lung function. Prospective studies and studies examining low-moderate levels (<50 µg/L), the level relevant for most populations worldwide, are limited. Methods: The Strong Heart Study is a prospective study of American Indian adults. The present analysis (n=2,166) used urinary arsenic measurements at baseline (1989-1991) and lung function measured by standardized spirometry at the second examination (1993-1995). We evaluated associations between arsenic exposure and airflow obstruction (FEV1/FVC ratio <0.70) and restrictive pattern (FVC <80% predicted with FEV1/FVC ratio >0.70); respiratory symptoms; and self-reported diagnosis of nonmalignant respiratory disease. Results: Airflow obstruction was present in 21.5% (458/2,132), and a restrictive pattern was present in 18.3% among those without obstruction (307/1,674). The odds ratio (95% confidence interval) for obstructive and restrictive patterns comparing the IQR of arsenic (µg/g creatinine) was 1.13 (0.96, 1.32) and 1.27 (1.01, 1.60), respectively, after full adjustment, including smoking, kidney function, and history of tuberculosis. Self-reported diagnosis of emphysema, frequent cough, phlegm with cough, and stopping for breath were also positively associated with arsenic. Conclusions: In this American Indian population, low-moderate inorganic arsenic exposure was positively associated with a lung restrictive pattern, higher self-reported emphysema, and respiratory symptoms, independent of smoking status. These findings suggest that low-moderate arsenic exposure can contribute to nonmalignant lung disease and may be associated with restrictive lung disease.

## **P01.1770. A Validated Environmental Health Literacy Scale to Improve Community Protection**

Cecilia Alcala

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**Abstract:** Background: Environmental health literacy (EHL) is essential for the general public's understanding of what and how environmental factors impact health. While several EHL tools exist, it is not clear if these have been validated. Methods: A three-pronged strategy was used to create the general EHL scale: 1) Item Generation- Using a Delphi approach, a group of environmental health (EH) scientists generated key items to be included in the scale, categorized into three domains: knowledge, attitude, and behavior. In the context of the study, knowledge is defined as EH facts and information gained through experience or education; attitude refers to a settled way of thinking or feeling about EH; and behavior is defined as the way in which an individual acts in response to EH concerns; 2) Item Review- The strongest items in each domain were selected by additional EH experts for inclusion in the scale; and 3) Scale Validation- The scale was then validated by two separate groups: 174 public health students and 98 community participants. The scale's factor structure was based on exploratory factor analysis (EFA) for the first group, while the model fit was assessed through confirmatory factor analysis (CFA) for the second group. Results: EFA analysis resulted in a three-factor solution. Three groups of model fit indices were used in the CFA analysis to assess model fitness; all indices indicated a good fit. Discussion: The resultant 9-item scale is psychometrically sound. This validated EHL scale will strengthen a broad range of EH research, bolster community engagement and citizen science, advance the efficacy of EH interventions, and build EH practice capacity. Three additional environmental media-specific subscales are currently being analyzed (air, water, food) and will further enhance the relevance of this general EHL scale.

**P01.1790. Knowledge and Awareness of Health Effects Related to the Use of Mercury in Small-Scale Artisanal Gold Mining in Suriname**

Paul Scheepers

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**Abstract:** The use of mercury in artisanal and small-scale gold mining has negative effects on human health and the environment. To reduce the use of mercury and subsequent health impact to gold miners and local inhabitants, knowledge and awareness in the community should be raised. This study evaluates the intervention effect of a health education programme on the levels of knowledge and awareness among local inhabitants and small-scale gold miners in active gold mining areas in the interior of Suriname, South-America. For this a total of 961 unique local inhabitants and 140 gold miners were interviewed. The interviews covered five topics: general knowledge of mercury, potential routes of exposure, health risks to children and adults, mercury related health effects and reproductive health risks. Additionally, participants were asked about potential exposure reduction techniques, and their willingness to participate in a future human biomonitoring programme. The health education programme influenced mainly knowledge on exposure routes of mercury (increase from 64% to 78% of the respondents who could name the relevant exposure routes) and knowledge on health effects attributed to mercury (increase from 48% to 70% of the respondents who were able to list the correct health effects). 70% of the respondents affirmed the higher sensitivity of children, and knowledge on reproductive health effects increased from 39% to 63%. Self-estimated levels of knowledge also increased, indicating higher levels of confidence. Gold miners reported to be willing to improve their work procedures (e.g. burning amalgam with a retort). However, suitable tools were not always available. Almost all respondents were willing to give consent for participation in a future human biomonitoring programme, for both themselves and their children. The implementation of a health education programme within a local healthcare structure proved effective and levels of knowledge and awareness improved.

## **P01.1800. Effect of Environmental Factors on Tuberculosis Patients Treatment Response at Lower Rift Valley, Southern Ethiopia**

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**Abstract:** Background: Emergence of Mycobacterium tuberculosis (Mtb) drug resistance strains mainly associated to the environmental factors exacerbating the global health crisis. Monitoring of immune response to anti-mycobacterial therapy can contribute to assess the effectiveness of a drug therapy. Objective: To explore the environmental factors affecting tuberculosis (TB) patients' immune response to the first line anti-tb drugs. Methods: Longitudinal cohort study was used to evaluate treatment response of TB patients. Eligibility criteria for recruitment were positivity for Acid Fast Bacilli Stain (AFB), culture "and" OR "or" GeneXpert MTB/RIF Assay, Body Mass Index (BMI) and Interferon Gamma Release Assay (IGRA) were mainly used to evaluate treatment response. Results: The mean±sd of the BMI increased from 19±0.5 at baseline to 20.9±0.5 at the end of the treatment. The IFN-γ response had decreasing trend from baseline mean±sd = 2.09±1.09 to the end of the treatment mean±sd = 0.23±0.20. At individual patient level, there was significant variability in baseline IFN-γ level and the variability was narrowed over time. No significant gender difference (49.8% among males versus 51.2% among females; Chi-square ( $\chi^2$ ) = 0.10; P = 0.41) and the age range of 24-65 years;  $\chi^2$  = 6.91; P = 0.075. Living at highland and for the agrarians (adjusted odds ratio/AOR = 2.62, 95% CI: 1.30, 5.28; P = 0.007), and living in the same house (AOR = 2.89, 95% CI: 1.09, 7.66; P = 0.033) were significantly associated with the increasing trend of IFN-γ response. The environmental factors (lowland residency and level of humidity) and social factors had no association to the IFN-γ response during the treatment (P>0.05). Conclusions: Information related to environmental and host related risk factors are very important to control the emergence of drug resistance strain by effective monitoring of treatment response.

**P01.1810. Cobalt and Thyroid Function. Case-Control Study of Patients with Goiters in Katanga, DR Congo**

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Abstract: High environmental exposure to cobalt has been documented in the general population of southern Katanga, as a result of intense mining activities. Cobalt has been shown to affect thyroid function in experimental animals and occupationally exposed persons. We aimed to determine the exposure to trace metals by biomonitoring of patients with goiters. During a government campaign offering free surgery, we included 32 adults with an untreated goiter documented by clinical and ultrasound examination, and thyroid function assessment by serum TSH, free triiodothyronine (FT3) and thyroxine (FT4). Controls (n=27) were adults undergoing surgery for various other conditions in the same hospital. Trace metals were measured in blood and spot urine samples by Inductively Coupled Plasma - Mass Spectrometry. Overall, no differences were found between trace metal concentrations of cases and controls, both groups exhibiting higher values of trace metals than reference values from industrially developed countries. Nevertheless, in 7 patients with hypothyroidism, FT4 and FT3 were negatively associated with blood cobalt (Spearman rho=-0.82) and blood cadmium (rho=-0.82), respectively. In 18 euthyroid patients, TSH was associated with blood cadmium (rho=0.54). In 7 hyperthyroid patients, TSH was associated with blood mercury (rho=-0.84). Serum FT4 was associated with urinary cobalt (rho=-0.49) and nickel (rho=-0.60) in euthyroid patients, and with urinary molybdenum (rho=0.79) and thallium (rho=-0.78) in hyperthyroid patients. This limited study found no differences in trace metal concentrations in blood or urine between untreated goiter patients and controls. However, when the heterogeneous group of untreated goiter patients was divided according to thyroid function, some associations with cobalt or other trace metals were observed. In particular, blood cobalt was negatively associated with FT4 among hypothyroid patients, thus suggesting a thyrotoxic effect of cobalt.

## **P01.1820. Temporal Distribution of Dengue Fever in Brazil from 1998 to 2017**

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**Abstract:** Dengue fever is considered the most widely disseminated vector-borne disease worldwide, and one of the most important public health problems. It has significant economic and social impact, especially in tropical and subtropical countries. Dengue fever is a febrile infectious disease caused by an arbovirus and transmitted in Brazil by the *Aedes aegypti* mosquito. In this country, dengue transmission has been continuous since 1986, and its first documented epidemic was recorded in 1982. **Objective:** To describe the cases of dengue fever in Brazil, reported from 1998 to 2017. **Method:** This study used the database of the Department of Informatics of the Brazilian Unified Health System and Ministry of Health Epidemiological Reports. **Results/Discussion:** Approximately 12 million cases of dengue were reported during the assessed 20-year period. Of these, nine million cases occurred in the last decade (2008 to 2017). It was observed that the number of cases increased year by year and that epidemics occur cyclically. The World Health Organization defines the level of epidemic transmission when the incidence rate is greater than 300 cases of dengue fever/100.000 inhabitants. The 1998 epidemic had an incidence of 313.8 cases/100.000 inhabitants, whereas in the year 2002 there were 398.8 cases/100.000 inhabitants. The years 2010, 2013, 2015 and 2016 were the most critical ones, with more than one million cases of dengue recorded each year. The largest epidemic occurred in 2015, with an incidence of 825.9 cases/100.000 inhabitants. In 2017, the incidence of dengue decreased considerably (121.2/100.000 inhabitants). Dengue has a seasonal pattern in Brazil, with a higher incidence in the first five months of the year, a warmer and more humid period. National policies for vector control, dengue fever prevention and clinical management of patients have progressed in the country. However, preventive actions that can minimize the impacts of dengue should be improved and constant.

## **P01.1830. Favorable Birth Outcomes in the Population of Tacna, Peru, despite Chronic Arsenic Exposure in Drinking Water**

Diego Fano

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Abstract: Tacna is a southern region of Peru, bordering with Chile and Bolivia. It presents valleys, sandy soils and inactive volcanoes. As it happens with Northern Chile and Argentina, Tacna possess high levels of arsenic in water, reaching values of 0.6812 mg/L, many times above the limit established by WHO (0.01 mg/L). The arsenic present have a geogenic origin derived from volcanic rocks. It is well known that continuous exposure leads increases risks of morbidity and mortality as different kinds of cancers, cardiovascular diseases and diabetes. Arsenic is able to cross the placenta, causing low birth weight, small for gestational age (SGA) and preterm birth. A recent work from our laboratory found extreme arsenic chronic exposure measured in drinking water in several districts of Tacna, without affecting negatively birth weight, or SGA and preterm birth prevalence as expected. In fact, these reproductive outcomes were not different according to exposure levels defined in quartiles [Q1 (0.0001-0.01 mg/L), Q2 (0.0220-0.0537 mg/L), Q3 (0.0545-0.2261 mg/L) and Q4 (0.2520-0.6812 mg/L)]. Nonetheless, arsenic speciation data was not available. These favorable birth outcomes could be evidence of 1) presence of non-toxic arsenic (organic Dimethylarsenic rather than inorganic) or 2) a positive selection for genetic polymorphisms in the gene *as3mt*; in charge of arsenic methylation, as those found in northern Chile and Argentina (San Antonio de los Cobres), conferring the fetuses a natural protection against arsenic toxicity. Given the reasons above, and the public interest, it is necessary conduct a research aimed to identify why high arsenic exposure is not associated with adverse reproductive outcome. These include measurements of urine, hair to detect different arsenic species and blood for polymorphisms e.g. *as3mt*. Group of study will be pregnant women in Tacna, in which different designs will be performed starting with a preliminary pilot study and finally a cohort study.

## **P01.1840. Using Birth Cohort Data to Estimate Prenatal Exposures for All Births around the New Bedford Harbor Superfund Site in Massachusetts**

Scott Bartell

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**Abstract:** Introduction: Children born near New Bedford, Massachusetts, USA have been prenatally exposed to environmental chemicals, in part due to an older housing stock, high fish consumption rates, and proximity to the New Bedford Harbor (NBH) Superfund site. Chemical exposure measures are not available for the general population, limiting epidemiologic investigations and potential interventions. Our objective was to leverage available sociodemographic and biomonitoring data from the New Bedford Cohort (NBC) to retrospectively estimate prenatal exposures for all 10,273 births between 1993-1998 in the 4 towns neighboring the NBH Superfund site. Methods: The NBC, a population-based cohort of 788 mother-infant pairs born between 1993-1998 near the NBH, collected questionnaire data and prenatal exposure biomarkers including cord serum polychlorinated biphenyls (PCB), *p,p'*-dichlorodiphenyl dichloroethylene (DDE), hexachlorobenzene (HCB), cord blood lead (Pb), and maternal hair mercury (Hg). We used bootstrapped samples of the NBC data to build prenatal exposure models, with multivariable smooths of birth location, birth year, maternal age at birth, and other NBC maternal sociodemographic characteristics as predictors. Results: Maternal country of birth was the strongest exposure predictor across all exposures with women from the Azores and Cape Verde having the highest levels. Maternal age, education, and marital status also were important predictors. The PCB, DDE, HCB, Pb, and Hg exposure models explained 55%, 53%, 41%, 43% and 38% of the variance, respectively. Conclusions: Our analyses suggest that multiple prenatal exposures can be estimated at the population level by modeling available data for a subset of the population. Predictive models using multivariable smoothing explained reasonable amounts of variance. Other exposure models with comparable performance have been used successfully in epidemiologic investigations to characterize exposure-outcome associations.

**P01.1850. Oxidative Stress Index Is Increased in Children of Riverside Towns Affected by Industrial Discharges in Central Mexico and Is Inversely Correlated with Metabolite Excretion of VOC**

Rocío López

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**Abstract:** INTRO The Atoyac River located into Tlaxcala and Puebla states in Mexico, has been classified as highly polluted by environmental authorities, several communities are settled on its banks, affecting around 1.5 million persons, as well as farmland. The river receives waste from industrial discharges, mainly in liquid form, containing a large amount of volatile organic compounds (VOCs), thus giving rise to an environmental distribution of toxics in the area. METHODS To demonstrate that this environment affects important physiological processes that have an impact in health, we conducted a study of schoolchildren from small communities on the banks of the river and in another similar town located far from it. 91 and 93 students (age range: 8-12, no diagnosed chronic disease), were studied from each site for oxidative stress index (OSI) in blood plasma samples, calculated from the total antioxidant capacity and the total oxidative status, BTEX metabolite excretion in urine samples, and relevant metabolic polymorphisms participating in the bioactivation-detoxification of most VOC: CYP2E1 RsaI, NQO1 C609T, and null polymorphisms of GSTT1 and GSTM1. RESULTS OSI was significantly higher in children living by the river ( $5.23 \pm 3.4$  vs  $2.59 \pm 1.46$ , 95% C.I.). At this site, OSI was correlated with diminishing metabolite excretion and a diminished antioxidant capacity; an association with allelic variants of the metabolic polymorphisms of CYP2E1 c2c2, GSTT1 present and NQO1 CC was also observed. CONCLUSIONS The expected health problems for these children as they grow older involves a wide array of disorders, including cancer and fertility risks for them and their children. Protection programs must be designed that include a constant monitoring of early biological effects, at the same time that environmental protection measures are applied to halt the deterioration of fundamental resources for a healthy life.

**P01.1860. Exposure to Heavy Metals and Respiratory Function among E-Waste Burners at Agbogbloshie, Accra**

Afua Asabea Amoabeng

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**Abstract:** Background: Dismantling and open air burning of electronic waste (e-waste) results in the release of mixtures of pollutants such as metallic dust, fumes and toxic gases deleterious to human health. Elevated biological and personal ambient air levels of heavy metals have previously been reported among e-waste workers at Agbogbloshie, Accra. Objective: The aim of this preliminary study was to assess the association between levels of heavy metals nickel (Ni) in urine, and lead (Pb) in blood and pulmonary function (Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC) and ratio of FEV1/FVC) among e-waste recyclers constantly involved in open air burning at Agbogbloshie, Accra. Methods: After ethical approval from the Ministry of Health, and receipt of consent from study participants, 10 ml of venous blood and 20 ml of urine was collected and analysed for Ni and Pb using the Atomic Absorption Spectrometer (PerkinElmer, Pin AAcle 900T, London, UK). Lung function indices (FVC, FEV1, FEV1/FVC) were obtained using a spirometer (Spirolab III, MIR, Italy). Mean values and standard deviations of heavy metals, FVC, FEV1, FEV1/FVC and proportions of respiratory symptoms were computed. Multivariate linear regression analysis was used to assess the associations between heavy metals in blood and urine and respiratory function parameters. Results: The most commonly self-reported respiratory symptoms were sore throat (50%), chest pains (45.5%), excessive phlegm (45.5%), and chronic cough (37%). The Mean concentrations (standard deviation) of the heavy metals were bPb 119.16 µg/L (47.10) and uNi 8.77µg/L (1.26). There was no significant association between the heavy metals and the measures of respiratory functions. Conclusions: This study showed elevated levels of lead and nickel in the blood and urine of the e-waste burners. However, there was no significant association between lung function and the heavy metals.

## **P01.1900. Environmental Contamination from E-Waste Activities: A Systematic Review**

Karel Houessionon

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**Abstract:** Introduction : The recycling of electronic waste (e-waste) contaminates ecosystems and people with a range of pollutants though to our knowledge the matter has yet to be reviewed through a systematic analysis. Methods : A systematic review process was adopted from the Office of Health Assessment and Translation from the U.S. National Toxicology Program. A full literature search on MEDLINE (PubMed) and Web of science was conducted using a priori key words and MeSH terms. The studies selected in this work are those dealing with heavy metals (Cd, Hg, As, Pb and Cr) in two media (soil and water). In total, 59 scientific papers that met the predefined criteria were identified and included in the review. Among others, the information was collected on the design, location of the study, type of heavy metal, and measurement. Until now a narrative synthesis has been conducted on all included studies with future plans to perform an analytical comparison. Results : In general, the literature provides information on the high contamination of soils, agricultural soils, surface water, river, well water, and drinking water by heavy metals. This contamination ranges from recycling sites to residential areas. More than 70% of the studies were conducted in Asia. Conversely, in the African region, only few, (<10%) studies have examined the problem of environmental contamination by heavy metals from e-waste, although several studies show that the problem is growing. Conclusion : Several studies have addressed the issue, but it is imperative to take a holistic approach of the growing e-waste issue. Key words : e-waste, heavy metals, soil, water, environment

## **P01.1910. Association of Low-Level Arsenic Exposure with Academic Achievement in Young Schoolers, a Cross-Sectional Study in Montevideo, Uruguay**

Gauri Desai

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**Abstract:** Background: Arsenic (As) exposure is associated with modest IQ deficits but its relation with children's academic achievement is understudied. Objectives: In this cross-sectional study, we examined the association between low-level As exposure and academic achievement among 5-8 year-old Uruguayan children, and tested for effect modification by As methylation capacity. Methods: We measured total urinary As (UAs) concentrations and the proportion of monomethylarsonic acid (%MMA) in urine of 328 children and assessed academic achievement using six subtests of the standardized Woodcock-Muñoz achievement battery. We tested the association between a continuous UAs measure adjusted for urinary specific gravity and tertiles of achievement subtest scores in ordinal logistic regressions. The models were adjusted for child's sex, BMI for age z scores, serum ferritin, blood lead, hemoglobin, and general intelligence; month of test, tester, mother's education, crowding at home, HOME inventory score, parental smoking, and household possessions. We assessed effect modification with the interaction term between %MMA and UAs, at  $p < 0.05$ . Results: The median UAs was 11.9  $\mu\text{g/l}$  (range = 1.4-93.9) and median %MMA was 9.42 (range=2.6-24.8). Each higher unit of UAs was associated with increased log odds of being in the higher tertile of the scores of three subtests - reading fluency (for low vs. mid and high tertile,  $\beta=0.06$ ; 95%CI: 0.01, 0.11), passage comprehension (for low vs. mid and high tertile,  $\beta=0.06$ ; 95%CI: 0.01, 0.12), and applied problems (for low vs. mid and high tertile,  $\beta=0.05$ ; 95%CI: 0.0001, 0.10) in covariate-adjusted models. We found no evidence of effect modification by %MMA. Conclusion: Scores on the reading fluency, passage comprehension, and applied problems subtests showed weak positive associations with As exposure, which need further examination in larger studies.

## **P01.1930. Blood Lead Is Associated with Latent Subgroups of Cognitive Performance in a Cross-Sectional Study of Uruguayan Children**

Seth Frndak

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**Abstract:** Introduction. Lead exposure, even at low levels, harms child cognition. The effect of lead across individual IQ domains, however, has been inconsistent in the literature. Latent cognitive subpopulations were identified to elucidate effects of lead across several cognitive domains simultaneously. Methods. Among of 357 children 5-8 years old from Montevideo, blood lead levels (BLL) were measured with atomic absorption spectroscopy. Cognitive performance was assessed using 3 tests from the Cambridge Neuropsychological Test Automated Battery (CANTAB): Intra-Extra Dimensional Shift (IED), Spatial Span (SSP) and Stockings of Cambridge (SOC), as well as the Woodcock-Muñoz cognitive battery (WM): Visual-Motor Integration, Verbal Comprehension, Visual-Auditory Comprehension, Concept Formation, Visual Spatial Thinking, Number Inversion and Spatial Relationship test. Bender Gestalt Test was also included. A total of 10 cognitive outcomes, reflecting differing domains of IQ were entered into a latent class analysis (LCA). After extracting cognitive classes, BLL was entered into an ordinal regression predicting cognitive class membership, controlling for socioeconomic and demographic confounders. Results. Mean BLL was 4.15 mg/dL and 31% children had BLL >5 mg/dL. Four latent classes were identified: A "High Performing" class (14%), an "Average" class (54%), a class performing well on SSP, but poorly on WM "Poor WM / Intact Memory" (17%), and a class performing poorly on WM, SOC and IED "Global Cognitive Impairment" (15%). Upper blood lead tertiles were associated with lower odds of membership in the higher performing classes: 2nd tertile OR = 0.50 (0.18, 1.40) and 3rd quintile OR = 0.54 (0.23, 1.25), although this did not reach statistical significance. Conclusions. Even at low concentrations, there is some evidence of a blood lead association with impairment across multiple cognitive domains.

**P01.1940. Sperm Aneuploidy in a Birth Cohort of Faroese Men Exposed in Utero to p,p-DDE and PCBs**

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Abstract: It is known that sperm aneuploidy contributes to early pregnancy losses, and to congenital abnormalities. Although the causes are unknown, environmental contaminants are suspected. Previously published data on 90 Faroese men showed that organochlorine exposure is associated with sperm disomy. Associations based on cord blood samples from a Faroese birth cohort (n=40) was apparent, but not statistically significant. This study aims to evaluate whether a significant association can be detected with a larger sample size. Serum and semen samples were obtained from 22-year-old men (n=100) who belonged in the birth cohort and participated in Faroe Islands health studies from 2009 to 2010. Serum samples were analyzed for p,p-DDE and major PCB congeners (118, 138, 153, and 180) and adjusted for total lipids. Cord blood and age-14 serum were available and were also analyzed for p,p-DDE and PCBs. Sperm fluorescence in situ hybridization (FISH) for chromosomes X, Y, and 18 was used to determine rates of XX18, XY18, YY18, and total disomy. Multivariable adjusted Poisson models (SAS GENMOD procedure) were used to estimate the relationship between organochlorine exposure and sperm disomy outcomes. The Poisson model was fitted using disomy measures (XX18, YY18, XY18, or total sex chromosome disomy) as the outcome variable, the natural logarithm of the number of sperm counted as the offset variable, the organochlorine exposure of interest as the independent variable. Age, abstinence time, smoking status, log of sperm concentration, motility, and morphology were all potential confounders controlled for in the adjusted analysis. Incidence rate ratios (IRRs) and 95% confidence intervals were calculated for each model. Because associations between cord blood concentrations of p,p-DDE and PCBs and sperm disomy in adulthood were not consistently significant in the original 40 men, we hypothesize that the addition of 50 men to this original cohort will yield more consistent results.

**P01.1950. Distribution of Polybrominated Diphenyl Ethers (PBDEs) in Newfoundland Diet: Possible Connection to Hypothyroidism**

Atanu Sarkar

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Abstract: Newfoundland sits directly in the Gulf of St. Lawrence and receives drainage from the Great Lakes watershed and the St. Lawrence River, both of which are contaminated with polybrominated diphenyl ethers (PBDEs) from anthropogenic sources. PBDEs have been inversely associated with thyroid hormones, and can also bioaccumulate in species to higher trophic levels. Seafood consumption is consistently found to be one of the main pathways for PBDE exposure in humans. The objective of this study is to explore if there may be a risk of human exposure to PBDEs from local seafood consumption in Newfoundland (NL). Liver samples from turbot (*Scophthalmus maximus*) and cod (*Gadus morhua*) were collected off the coasts of NL, and analyzed by gas chromatography/mass spectrometry for PBDE congeners. Residents in Burin (south coast) and New-Wes-Valley (northeast coast) completed a seafood consumption survey and gave blood samples to be tested for thyroid hormone levels and PBDE concentrations. BDEs-28, 47, 99, 156, 209, and methoxylated polybrominated diphenyl ethers 47 (MeO-BDE-47) and 68 (MeO-BDE-68) were detected in fish liver tissue from all sampling locations around NL. Concentrations of  $\Sigma$ PBDEs (5.52-11.75 ng/g) did not differ in concentration coastwise or by species. Results from the seafood consumption survey and human blood samples will be available for the conference. PBDE concentrations in fish liver do not differ by species or location, therefore there may be PBDEs in the Labrador current and from the St. Lawrence River affecting the marine food chain around NL. This study is the first to document PBDE contamination in the Newfoundland coastal waters and population, and adds to past research on health effects of PBDE contamination from the St. Lawrence River. This research will help inform policy development of chemicals use and regulation in Canada, and increase research into environmental contamination and public health.

## **P01.1960. Change in Obesity Prevalence Attributable to Reduction of Sodium Intake in Korean Adults**

Jong-Tae Lee

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**Abstract:** Background: Sodium intake is considered to be an important risk factor of obesity. In South Korea, sodium reduction policy has been implemented since 2010. The aim of this study was to identify the relationship between sodium and obesity and to investigate the change in the number of obese patients attributable to sodium intake before and after the policy. Method: This study used Korean National Health and Nutrition Examination Survey, 2007-2016. We applied logistic regressions to examine association between logarithm of daily sodium intake and obesity (BMI  $\geq$  25 kg/m<sup>2</sup>). We adjusted for demographic factors, health behaviors, and socioeconomic status. We calculated odds ratios and annual attributable number of obese patients stratified by gender. Result: The overall prevalence of obesity was 36.16% and 29.38% for men and women, respectively. There was a significant reduction in sodium intake from 2010 to 2016. The odds ratios of obesity per unit increase were 1.259 (95% CI, 1.163-1.362) and 1.068 (95% CI, 1.002-1.138) for men and women, respectively. The number of obese patients attributable for sodium intake was reduced by 7.3 per 1000 people, 2.6 per 1000people in men and women, respectively, since implementation of sodium reduction policy. Conclusion: Our findings suggest that a high sodium intake is associated with increasing risk of obesity. The decrease in the number of obese patients attributable to sodium intake suggests that the sodium reduction policy is effective in reducing obesity.

## **P01.1970. Dietary Persistent Organic Pollutants Exposure, Omega-3 Fatty Acid Intake and Type 2 Diabetes among First Nations in Canada**

Lesya Marushka

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**Abstract:** The prevalence of type 2 diabetes (T2D) among First Nations (FNs) in Canada is 3 to 5 times higher than that in the general population. Besides lifestyle factors, such as physical inactivity and poor diet, exposure to persistent organic pollutants (POP) was reported to increase the risk of T2D. On the other hand, omega-3 fatty acids (n-3 FA) from fish may have a beneficial effect on T2D. This study aims to investigate the associations between POP exposure and n-3 FA intake from fish with the prevalence of T2D in a nationally representative sample of First Nations in Canada, living on-reserve south of the 60th parallel. Dietary, health and lifestyle data from the First Nations Food Nutrition and Environment Study, a cross-sectional study (2008-2017), were analyzed. The sample consisted of 6094 FNs adults living in 85 communities across Canada. The consumption of locally-harvested fish was estimated with a food frequency questionnaire. Fish samples were analyzed for the presence of POP including dichlorodiphenyldichloroethylene (DDE) and polychlorinated biphenyls (PCBs). Dietary n-3 FA intake was determined using the Canadian Nutrient File. The associations between dietary POP, n-3 FA and self-reported T2D were investigated using multiple logistic regression models adjusted for confounding factors. We will discuss the results in the context of risk-benefit assessment and use the evidence to support the development of dietary advisory associated with POP exposure.

**P01.1980. Study on the Application Effect of School-Family Integrated Intervention Model in Correcting Adolescent Unhealthy Eye Hygiene Habits**

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**Abstract:** Object: The generation and development of myopia is closely related to the eye hygiene habits. The purpose of this study is to evaluate the effect of school-family integrated intervention on changing adolescent myopia related behaviors. Methods: This was a pretest and posttest quasi-experimental design. A random sampling method was used to select 5564 students in Wuhan, Hubei province (China). Experts in the field of ophthalmology, epidemiology and health management do health education for teachers and parents to introduce correct eye hygiene habits and methods of myopia prevention. Since September 2015, teachers and parents conducted 1 years of supervision and comprehensive intervention on the students' eye hygiene behaviors with guidance of experts. Before and after the experiment, a number of variables related to eye hygiene habits were evaluated. Data were analyzed using independent samples Student's t test and Pearson  $\chi^2$ . Result: The comparison of the variables before and after the intervention showed significant statistical differences. Through intervention, the average time of continuous reading and writing decreased from (1.61±1.01) hours/day to (1.56±1.04) hours/day( $t=3.97, p<0.001$ ), outdoor activity increased from (1.52±0.90) hours/day to (1.77±0.93) hours/day( $t=3.970, p<0.001$ ) and continuous watching TV or cellphone reduced from (1.73±1.31) hours/day to (1.41±1.13) hours/day ( $t=23.54, p<0.001$ ). Moreover, the proportion of student who paid attention to the posture of reading and writing increased from 27.3% to 56.5% ( $\chi^2=974.74, p<0.001$ ), and did overlooking exercise daily increased from 23.8% to 49.7% ( $\chi^2=807.12, p<0.001$ ), and did eye exercise daily increased from 38.8% to 53.3% ( $\chi^2=234.42, p<0.001$ ), and took note of distance between eye and TV or cellphone increased from 46.1% to 57.7% ( $\chi^2=150.22, p<0.001$ ). Conclusion: The school-family integrated intervention model can effectively improve adolescent eye hygiene habits.

**P01.1990. Effects of Lead, Mercury, Manganese and Cadmium Co-Exposure on Preschool Children's Serum BDNF Levels in Taizhou, China**

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Abstract: It has been indicated that metals can lead to adverse effects on nervous system in children. Brain derived neurotrophic factor (BDNF) plays an important role in the survival, growth and development of neurons. However, the relationship between blood metal concentrations such as lead (Pb), mercury (Hg), manganese (Mn), cadmium (Cd) and serum BDNF levels was little demonstrated. A total of 574 preschool children (average age of 60 months; 307 boys and 267 girls) living in polluted areas (Taizhou, China) were recruited to participate in this study. Blood Pb, Hg, Mn and Cd levels were determined by the tungsten atomizer absorption spectrophotometer. Serum BDNF levels were determined by ELISA kits. The geometric means of blood Pb, Hg, Mn and Cd levels of all participants were 76.26 µg/L, 1.27 µg/L, 23.96 µg/L and 0.28 µg/L respectively. The Serum BDNF levels of girls was significantly high than that of boys ( $P < 0.01$ ). After adjusting confounders, general liner model showed that only blood Cd levels had a significant negative association with serum BDNF levels ( $\beta = -0.03$ , 95% CI: -0.05--0.01). Serum BDNF levels were significantly negative association with blood Mn and Cd levels for girls, but not for boys ( $\beta = -0.142$ , 95% CI: -0.282--0.002;  $\beta = -0.041$ , 95% CI: -0.073--0.009). Furthermore, significant positive correlation between blood Mn and blood Cd levels ( $P < 0.0001$ ) and positive interaction between blood Mn and Cd levels on serum BDNF were observed ( $\beta = -0.11$ , 95% CI: -0.17--0.05). This study suggest a negative association between elevated Cd exposure and serum BDNF levels. Elevated Cd, Mn exposure presenting more pronounced effects on girls. Cd and Mn may have interactive adverse effects on nervous system in children.

## **P01.2000. Investigating Health-Relevant Air Pollution Concentration Linkages across Multiple Seasons during Indoor Cookstove Campaign in Rural India**

Julian Marshall

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**Abstract:** Biomass combustion in residential cookstoves is a major source of air pollution and a large contributor to the global burden of disease. Carbon financing offers a potential funding source for health-relevant energy technologies in developing countries. We conducted a randomized intervention study to evaluate air pollution impacts of a carbon finance-approved cookstove intervention in rural South India. Prior research on this topic often has used time-integrated measures of indoor air quality. Here, we employed real-time monitors, thereby allowing investigation of diurnal and hourly trends in concentrations. We measured 24h indoor concentrations of fine particulate matter (PM<sub>2.5</sub>), black carbon (BC) and carbon monoxide (CO) in intervention households (used newer, rocket-type stoves) and control households ("nonintervention"; continued using traditional open fire stoves). We conducted "per protocol" versus "intent to treat" analyses, and compared 24h averages of air pollutants versus cooking hours only averages. Cookstoves were associated with non-significant reductions in CO (1.5 ppm,  $p=0.28$ ) and PM<sub>2.5</sub> (148  $\mu\text{g}/\text{m}^3$ ,  $p=0.46$ ) but increased BC concentration (39  $\mu\text{g}/\text{m}^3$ ,  $p<0.05$ ) and the ratio of BC/PM<sub>2.5</sub> (25%,  $p<0.05$ ) during cooking-relevant hours-of-day relative to controls. Calculated median effective air exchange rates based on decay in CO concentrations were stable between seasons (season 1: 2.5 h<sup>-1</sup>, season 2: 2.8 h<sup>-1</sup>).

**P01.2010. In Search of Preventive Measures for Reducing Lead Exposure in Children Who Live in Lead Smelter and Mining Communities**

Landon MacGillivray

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Abstract: Environmental lead exposure even at low levels may result in persistent, long-term neuro-developmental adverse effects in young children. Extensive literature has demonstrated childhood lead exposure results in a decrease in intelligence quotient (IQ) points. There is no known safe blood lead level (BLL) and poor outcomes are associated with BLLs as low as 1-2 µg/dL. In communities adjacent to active smelters or mines, such as Trail, British Columbia, a continuous source of environmental lead exposure exists and implementation of preventive measures is vital. Our objective was to evaluate the effectiveness of different strategies and preventive measures utilized in communities adjacent to mining or smelter operations to mitigate environmental lead contamination. We conducted a literature review and summarized our findings in a report using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines. We compared the type of proposed interventions in the scientific literature with the current interventions already implemented in Trail. Then based on considerations surrounding the effectiveness of each intervention, we proposed additional interventions to complement current efforts in Trail. In communities with active lead smelter and mining operations, stack and fugitive emission reductions via governmental policy changes, technology advancement or plant closure have far superior outcomes compared to other preventive measures. Multifactorial approaches are also necessary to manage ongoing lead exposure. In Trail, fugitive dust emissions are identified as the primary source of environmental lead contamination. With significant collaborative efforts in recent years, a multitude of measures have been implemented in Trail, to minimize potential risk of ongoing contamination. We hope our findings will help this collaborative effort to further enhance interventions and take into consideration other possible approaches proposed in our report.

## **P01.2020. Predictors of Urinary Phenol and Paraben Concentrations among Pregnant Women in Northern Puerto Rico**

Pahriya Ashrap

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**Abstract:** In light of potential health impacts associated with phenol and paraben exposure, targeted action for the elimination or reduction of exposure sources may be warranted. However, little is known regarding important sources and pathways of exposure. This is particularly important in areas such as Puerto Rico, where residents have higher exposures to many of these chemicals, as well as higher rates of many adverse health outcomes, compared to the mainland US. The objective of this study was to determine concentrations and predictors of urinary phenol and paraben biomarkers measured at multiple times during pregnancy among women living in Northern Puerto Rico. We recruited 1003 pregnant women from prenatal clinics and collected urine samples and questionnaire data at up to three separate visits between 16 to 28 weeks gestation. Urine samples were analyzed for eight phenols and four parabens: 2,4-dichlorophenol (24-DCP), 2,5-dichlorophenol (25-DCP), benzophenone-3 (BP-3), bisphenol A (BPA), bisphenol S (BPS), bisphenol F (BPF), triclosan (TCS), triclocarban (TCC), butyl paraben (B-PB), ethyl paraben (E-PB), methyl paraben (M-PB), and propyl paraben (P-PB). Detectable biomarker concentrations among pregnant women was prevalent and tended to be higher than those measured in women of reproductive age from the general US population. A decreasing temporal trend was statistically significant for urine concentrations of BPA, while BPS showed an increasing temporal trend. We found significant positive associations between biomarker concentrations with self-reported use of products. There was an increasing trend of TCC/TCS concentrations with increased concentrations of TCC/TCS listed as the active ingredient in the bar soap/liquid soap products that were reported being used. Our results suggest several potentially important exposure sources to phenols and parabens in this population and can inform targeted approaches to reduce exposure to these chemicals or their precursors.

## **P01.2030. An Effect of Maternal Secondhand Smoke Exposure at Early Pregnancy on Autistic Behaviors at 5 Years of Age**

Hyunjoo Joo

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**Abstract:** Autism Spectrum Disorders is a syndrome with multiple causes and different mechanisms leading to abnormal development. Only a few longitudinal studies have investigated the association between maternal SHS exposure and autistic behaviors. We examined the effect of Secondhand Smoke exposure on the autistic behaviors in children at 5 years to identify the sensitive time window of exposure considering potential gender difference. A total of 1,751 pregnant women and children participated in the prospective birth cohort study, Mothers and Children's Health study since 2006. Information concerning SHS exposure was obtained from the children's parents or guardians by means of a self-administered questionnaire that included a set of standardized questions commonly used in previous studies. A total of 458 children at 5 years were assessed for behavior by using the Social Responsiveness Scale (SRS). The association between SHS exposure at each time window and autistic behaviors was examined using generalized linear model adjusted for maternal age at pregnancy, maternal educational level, household income, household income, residential area, parity and early blood lead. SHS exposure at early pregnancy was significantly associated risk of autistic behaviors in boys while it was not at postnatal periods: for SHS in early pregnancy, score of Total - SRS increased by 2.66(95% CI 0.06, 5.26) in boys, in which the interaction effect of gender was significant ( $p$ -interaction: 0.01). However, the SHS exposure at any time did not show a significant association with autistic behaviors in girls. SHS exposure on children's autistic behavior at 5 years showed a susceptible exposure time window of early fetal period in boys. SHS exposure did not show an association with autistic behaviors in girls.

**P01.2040. Trace Metal Exposure and Health Effects among Urban Children Living in Areas with Different Degrees of Pollution in Lubumbashi, DR Congo**

Paul Musa Obadia

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Abstract: Lubumbashi is the capital city of the (former) Katanga province in DR Congo and hosts many copper-cobalt mines and refining plants that are past and current sources of pollution. We investigated trace metal exposure and possible respiratory health effects among children living in two urban neighbourhoods with different degrees of pollution. During two campaigns conducted in August 2012 (dry season) and January 2013 (rainy season), we recruited children (9-13 y) in Tshamilemba, close to a metal refinery (n=199), and in Maramba, taken as a control area (n=170). We administered a respiratory questionnaire, gave diaries for recording symptoms during two weeks, and performed spirometry. Concentrations of 25 trace metals were measured by inductive coupled plasma - mass spectrometry in spot samples of urine. Metals were also measured in local well waters. Airborne particulate matter (PM10) was collected by static air sampling pumps. Mean PM10 was 121 µg/m<sup>3</sup> and 103 µg/m<sup>3</sup> in Tshamilemba and Maramba, respectively. Geometric mean (GM, with IQR) concentrations (µg/L) of cobalt in well water were 10-fold higher in Tshamilemba [8 (0.1-2632)] than Maramba [0.8 (0.1-3.9)]. GM (IQR) urinary concentrations (µg/g creatinine) of cobalt were higher in Tshamilemba [dry season 16.5 (6.9-29.0); rainy season 20.2 (10.3-33.0)] than Maramba [4.1 (1.8-9.8); 11.9 (5.0-20.1)]. Prevalence of cough during the two weeks of observation was higher in Tshamilemba (13%) than in Maramba (1%), but other symptoms (eyes, skin, wheezing, dyspnea) did not differ. The groups did not differ significantly in pulmonary function indices. In this cross-sectional study, we found evidence of higher exposure to trace metals, especially cobalt, in Tshamilemba than Maramba, but apart from a higher prevalence of cough in Tshamilemba, no other differences in respiratory health were found between the more highly exposed children and the control children.

## **P01.2050. Spatial and Temporal Variability of Soil Metal Contaminants in the Animas and San Juan Watershed Downstream from Legacy Mining**

Gaurav Jha

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**Abstract:** On August 5, 2015, three million gallons of acidic, metal-laden water was accidentally released into the Animas River from the Gold King Mine (GKM) in Silverton, Colorado. The majority of contamination released by the GKM spill existed mainly as suspended solids likely deposited within the streambed sediment of the Animas and San Juan Rivers, as well as in irrigation ditches that could not be closed ahead of the arrival of the contaminated plume. While contamination from this one event may not have reached the closed irrigation ditches and fields, legacy mining that may have released metals into the watershed over the last 150 years may have accumulated in the soils. The goal of this project is to determine the concentration of metals in agricultural fields and irrigation ditches across the Animas watershed. The concentration of 9 heavy metals (Al, As, Pb, Cu, Cr, Ca, Mn, Zn, Fe) are determined using the Portable X-Ray fluorescence in irrigation ditches, three different vegetations of agricultural fields (soil and plant samples). The average concentration of As exceeded the guideline value (7.07 ppm) specified by NMED at certain hotspots identified for pasture (7.19 ppm), alfalfa (6.92 ppm) and vegetable (7.13 ppm) fields. On observing the exceedances at areas close to the irrigation sources plant samples were collected in four quadrants in a gradient of irrigation water flow in the field. The concentration range of As in plant tissue for pasture (0.89-1.25 ppm, n = 12), alfalfa (0.94-1.11 ppm, n = 12) and vegetable (0.5-0.9 ppm, n = 24) fields were below the guideline value of 1.7 ppm (Kabata-Pendias, 2011). The higher concentrations of arsenic and manganese that were found in some hotspots did not correlate to increased concentration of metal uptake in plants. The ongoing research for another season will help the people in Navajo Nation to make decisions about the safety of the soils to resume the ceremonial uses of soil and the cultivation of agricultural crops.

## **P01.2060. Exposure of Inorganic Mercury in the General Population and Ethnic Minorities in New York City and Its Associations with Skin Lightening Practice**

Chi Wen

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Abstract: Skin lightening practice (SLP) was identified as a source of inorganic mercury exposure among Caribbeanborn blacks and Dominicans, who had geometric mean urine mercury concentration ([GMuHg])  $\geq 1$  ng/ml compared to 0.69 ng/ml among the general population in the 2004 New York City Health and Nutrition Examination Survey (NYC HANES). We assessed such a pattern using the 2013-2014 HANES (n=1408), which also asked about the usage of skin lightening cream in the past 30 days. In addition, we present the preliminary results from a pilot study on SLP among NYC women of African and Afro-Caribbean ancestries (n=74) who have been bleaching their skin for a year. The population-weighted SLP prevalence was 5.5% overall and 8.1% among the Caribbean population (n=355). The overall [GMuHg] and its 95th percentile was 0.37 and 1.7 ng/ml, similar to the levels found among subgroups such as participants with SLP, the Caribbean population, or the Caribbean participants with SLP. Among those with SLP (n=75), 70% were female, 37% were Hispanic, 36% were Caribbean, and their [uHg] ranged from 0.063 ng/ml to 11ng/ml. Significant factors ( $p < 0.05$ ) associated with [uHg] were being non-US born, higher family income ( $\geq \$100,000$ ), having silver-colored dental fillings and frequent fish or shellfish consumption ( $\geq 3$  times in the past 30 days). In our pilot study, 81% participants were non-US born, about 50% from Jamaica or the Ivory Coast, 89% reported more than 3 years of SLP, 77% used daily, and 12% used while pregnant/breastfeeding. We observed an overall decrease in the population level [GMuHg] in NYC compared to the previous study, and did not find elevated [GMuHg] among the Caribbean or SLP population. Our SLP-focused pilot study showed that SLP is a habitual practice, and the existence of prenatal and postnatal exposures related to SLP may warrant further investigation especially among vulnerable subgroups (e.g., Jamaicans and West Africans) where SLP is more prevalent.

## **P01.2070. Does Overall Environmental Quality Affect End-Stage Renal Disease Survival?**

Marissa Kosnik

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**Abstract:** Prevalence of end-stage renal disease (ESRD) in the U.S. increased by 74% from 2000 to 2013, with a 5-year survival of only 42%. To investigate associations between environmental quality and ESRD survival time, we used the Environmental Quality Index (EQI), an aggregate measure of ambient environmental quality at a county level across the U.S., composed of five domains (air, water, land, built, and sociodemographic). Associations between EQI and survival time for 1,091,742 people with ESRD (18y or older and without changes in county residence) from the US Renal Data System were evaluated using proportional-hazards models adjusting for sex, race, age at first ESRD service date, body mass index, alcohol and tobacco use post ESRD diagnosis, and rurality. The models compared the overall EQI percentiles [0-5), [5-20), [20-40), [40-60), [60-80), [80-95), and [95-100], where lower percentiles are interpreted as better EQI. Stratification of findings by age and distance from nearest hospital were examined. >50% of people lived in the two worst (i.e. highest) EQI percentiles. In the full model, there was no consistent direction of association across EQI strata. While age was a significant predictor of survival (Hazard Ratio, 4.27; 95% Confidence Interval, 4.21-4.33 for people > 65 vs. people < 40), there was no evidence of age-specific association with EQI. When considering distance from the nearest hospital, those living ≤10 miles had increased survival in the worst EQI strata (median survival 3.0 vs. 3.5 years for best vs. worst EQI, respectively); however, for people living >20 miles from a hospital, median survival was higher in the best (4.2) vs worst (3.4) EQI. This association held across different rural/urban categories and age groups. While studies have reported associations between EQI and many health outcomes, additional factors should be considered for modeling ESRD survival. This abstract does not reflect EPA policy.

## **P01.2080. Social Environment Change and Social Health Outcomes**

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**Abstract:** Background: In 2012, 12.6 million deaths globally were attributable to the environment. When accounting for both death and disability, the fraction of the global burden of disease due to the environment is 22% (95% CI: 13-32%). Deaths from environment risks could be prevented, if environmental risks were removed. Objectives: This study aims to share information on the practice and explain the effects of social environment change on social health outcome, based on CDC and community health service center data from a district in Wuhan, China. Methods: A Health in all polices based city practice was conducted in one of the district in Wuhan. Statistical analysis were conducted in SPSS, data were estimated using comparative risk assessment (CRA) method. Results: 1) the health outcomes improved markedly, such as residents' life expectancy has risen to 80.23 years from 79.22 years, maternal mortality per 100,000 newborns has decreased to 10.29 from 11.12, infant mortality rate per 1,000 infants has decreased to 3.80 from 4.78 and children under 5 mortality rate has decreased from 6.89% to 4.42% during three years exploring; 2) the effects of social environment change on medical institutions' medical expenses indicated that the growth rate of residents' medical expenses of residents has slowed down, and the number of hospital patients admissions and hospital days has also decreased. Conclusions: We concluded that three years' social environment change yielded positive effects on the health outcomes of the population, and controlling growth of medical expenses.

**P01.2100. Health-Related Needs Assessment of Artisanal Small-Scale Goldminers in Kadoma/Zimbabwe: Paving the Way for Health Improving Interventions**

Jana Becker

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Abstract: Background: Small-scale miners are responsible for over 50 % of the Zimbabwean gold production. However, the sector is characterised by high labour-intensity, low productivity and capital and outdated technologies. Sustainable health interventions are necessary. Objective: The objective of the project was the empirical identification of miners' health needs and corresponding effective, sustainable, and successful future health interventions. Methods: In a two-week field study in Kadoma, Zimbabwe, in late 2017 a health needs assessment was done to determine the miners' needs by applying a mixed methods approach. This included qualitative and quantitative interviews with individuals, group interviews, focus group discussions and observations. Results: A total of 89 miners and 4 health care workers participated in the project. Six main themes with potential for improving miners' health were identified: living conditions, nutrition/hygiene; safe work environment/mining processes; financial support; health care services; education. Especially the need for formalisation and funding as well as low importance of certain interventions to miners are obstacles to sustainable health interventions. Formalisation can only be successful, if the miners' perceptions of governmental involvement are considered and if the reluctance of failed formalisation attempts can be overcome. As the underlying basis for all these approaches, an increase in knowledge and awareness of miners is needed, especially by considering the growing numbers of miners. Conclusion: By taking into account the possible health impacts, the feasibility of interventions, the importance for miners, and their willingness to adapt, interventions aiming at increasing the knowledge and awareness of miners have been identified as most promising for sustainable occupational health. Funding by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety is gratefully acknowledged.

## P01. Prenatal and Early Life Exposures and Effects 1

### **P01.2110. Impact of Mercury Exposure on Health-Related Quality of Life during Pregnancy in Suriname**

Anisma Gokoel

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**Abstract:** Background: The abundant use of mercury in illegal gold mining in Suriname's interior is of growing concern. The Caribbean Consortium for Research in Environmental and Occupational Health is assessing exposure to Hg in pregnant women and their offspring. This study evaluated the association between Hg levels, perceived health and Health-Related Quality of Life (HRQoL) in Surinamese pregnant women. Methods: Data of 311 pregnant women were analyzed using standardized questionnaires completed during early pregnancy. HRQoL was assessed using seven out of eight scales from the Rand SF-36: physical functioning, role physical, bodily pain, vitality, general health, role emotional and mental health (high scores indicates good health). Perceived health was measured with a 5-point Likert scale. The association among Hg, perceived health, and HRQoL were assessed with adjustment for maternal sociodemographic factors. Results: 83 women (26.7%) had elevated Hg levels that exceeded the USEPA action level (1.1 µg/g); no significant association was observed with perceived health and HRQoL. 75.9% of the women with elevated mercury levels had a good perceived health, compared with 71.1% of the women with normal Hg levels ( $p=0.47$ ). Perceived health was significantly associated with each HRQoL scale ( $p<0.01$ ). For each scale higher mean scale scores were observed among women with elevated Hg levels, except for vitality and mental health; Cohen's effect sizes were small (0.04-0.11). Bivariate analyses showed a borderline association between education (secondary or lower vs. higher) and perceived health (OR: 2.0; 95%CI: 0.95-4.08); and region (interior vs. else) and perceived health (OR: 3.4; 95%CI: 0.90-13.0). Conclusion: One out of four pregnant Surinamese women had hair Hg levels above the USEPA action level; these were not associated with lower HRQoL scores and poor perceived health during early pregnancy. Funding: FIC/NIH U01TW010087-01, U2RTW010104

## **P01.2120. Association between Phenols and Parabens with Gestational Age, and the Modifying Effect of Life Events during Pregnancy**

Amira Aker

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**Abstract:** Background: Exposure to phenols and parabens, as well as positive and negative life events, have been associated with adverse birth outcomes. However, no studies have looked at the combined effect of these environmental chemicals and life events on birth outcomes. We examined the associations of these environmental chemicals and the Life Events Score (LES) in 922 pregnant women in a cohort of pregnant women in Puerto Rico. Methods: Urinary phenols and parabens were measured at three time points in pregnancy (visit 1: 16-20 weeks, visit 2: 20-24 weeks and visit 3: 24-28 weeks gestation). LES was calculated via a questionnaire at visit 2. Multiple linear regression (MLR) models were constructed to regress gestational age against each of the average levels of phenols and parabens. An interaction term between each chemical and LES was included in the MLR models. All results were transformed into the change in the number of gestational days for an inter-quartile-range difference in the exposure ( $\Delta$ ). Results: The average benzophenone-3, methyl- and propylparaben levels were associated with a 1-2 day increase in gestational age [( $\Delta$  1.90; 95% CI: 0.54, 3.26); ( $\Delta$  1.63; 95% CI: 0.37, 2.89); ( $\Delta$  2.06; 95% CI: 0.63, 3.48), respectively]. TCC was associated with a suggestive 2 day decrease in gestational age ( $\Delta$  -1.96; 95% CI: -4.11, 0.19). The interaction terms between LES and bisphenol-S, bisphenol-F, triclocarban, ethyl- and propylparaben had p values < 0.05. Among these with a significant interaction, LES scores below -1 were associated with 0.5-4 day decrease in gestational age, except for propylparaben, which was associated with a 3 day increase in gestational age. This was driven by a lack of positive events, rather an excess of negative events. Conclusion: BP-3, MPB and PPB were associated with an increase in gestational age. LES modified the association between some chemicals and gestational age. Further studies are required to substantiate these findings.

## **P01.2121. Early-Life Infections, Immune Dysregulation, and Childhood Acute Lymphocytic Leukemia in Costa Rica**

Sophia Colombari Figueroa

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**Abstract:** Introduction: Despite the high incidence of leukemia in Hispanic children, few studies have examined the role of early immune stimulation in the etiology of leukemia in this high-risk population. Methods: We used data from a population-based retrospective case-control study conducted in Costa Rica (2001-2003) to examine the role of early-life infections and immune dysregulation on leukemia incidence among Hispanic children. Cases of ALL (n=239) were diagnosed in 1995-2000 (age <15 years at diagnosis) and were identified through the National Cancer Registry and National Children's Hospital. Population controls (n=579) were frequency-matched to cases by birth year and drawn from the National Birth Registry. Surrogate measures of early immune stimulation were collected through home interviews. Unconditional logistic regression models were adjusted for birth year, sex, and socioeconomic status. Results: Daycare attendance, contact with any pet or farm animal, and a complete vaccination scheme were inversely associated with odds of ALL (OR=0.67, 95% CI: 0.47-0.95; OR=0.39, 95% CI: 0.26-0.59; OR=0.35, 95% CI: 0.18-0.67; respectively). In contrast, experiencing a fever longer than one week (censored in the year prior to diagnosis) was positively associated with ALL (OR=2.53, 95% CI: 1.66-3.85). Breastfeeding, birth order, primary infections, and hospitalizations were not significantly associated with risk of childhood leukemia. Conclusion: Our findings are consistent with the epidemiology of childhood leukemia in non-Hispanic populations and provide additional support for Greaves hypothesis that exposure to infectious agents in early childhood is a protective factor. The observation that having a fever longer than a week increases risk supports an emerging theory that an abnormally strong immune response to infection increases susceptibility to leukemia.

**P01.2130. Urinary Concentrations of Bisphenol-F and Their Associations with Environmental Factors of Pregnant Women: The Mother and Kids Environmental Health (MAKE) Study**

Bohye Shin

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**Abstract:** Background/Aim Bisphenol-F(BPF) is a substitute substances of bisphenol-A and the manufacturing of plastics and epoxy resins(such as food contact materials, structural adhesive). However, the exposure of BPF in pregnant women is presently unknown. This study aimed to examine urinary BPF concentrations of pregnant women and investigate their associations with environmental factors. Methods In order to find out the association with BPF and environmental factors, we plan to recruit more than 300 women during 2nd and 3rd stage pregnancy between 2017 and 2019 in the Korean pregnant women. We also collected information on birth outcome, socio-economic status, use of disposable foods, and consumption habits of consumer products. Multiple regression analysis was performed to assess the effect of BPF exposure by environmental factors. Results The creatinine-adjusted geometric mean of BPF were 0.2 $\mu$ g (95% CI: 0.40-5.49) and that was tended to increase of environmental factors. There were significant associations was observed between BPF and use of plastic cooking tools ( $\beta$ =0.88,  $p$ =0.006), intake of wrapping food ( $\beta$ =0.7,  $p$ =0.05), habits of using perfume ( $\beta$ =0.69,  $p$ =0.05), respectively. None of the BPF concentrations were associated with the other consumer products and food. In addition, we found the associations with BPF and renovation of the house within the last 6 months ( $\beta$ =0.97,  $p$ =0.02). Conclusions We expect this study to provide evidence to support the hypothesis that the environmental factor has an effect on the exposure during pregnancy.

## **P01.2150. Prenatal Persistent Halogenated EDCs and Gestational Glucose Levels in a Racially Diverse Pregnancy Cohort of Overweight Women**

Suril Mehta

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**Abstract:** Background: Animal and human studies suggest certain endocrine disrupting chemicals (EDCs) affect glucose regulation; however, the impact of these chemicals during pregnancy on maternal glucose levels and gestational diabetes (GD) risk has been sparsely examined. Objective: To examine the role of prenatal EDC exposure on fasting plasma glucose (FPG) and GD during pregnancy in overweight women. Methods: A racially diverse, low-income cohort of 103 overweight pregnant women participated in a healthy weight gain behavioral intervention. Single serum measurements of poly- and perfluoroalkyl substances (PFASs), polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls (PCBs), and FPG (collected via a fasting blood draw) were taken at late first or second trimester. Physician-diagnosis of GD was determined through medical chart abstraction. We used generalized linear models to assess cross-sectional associations between exposure to EDCs and FPG, and logistic regression to examine associations with incidence of GD after adjusting for age, race/ethnicity, BMI, education, and gestational age at blood draw. Results: The mean FPG was  $4.43 \pm 0.39$  mmol/L. GD or a FPG  $\geq 5.1$  mmol/L was seen in 11.7% of women. A twofold increase of PCB-138 and PCB-153 were associated with 8.17% (95% CI: 1.02, 15.82) and 11.38% (95% CI: 0.65, 23.25) increase in FPG, respectively. A doubling of PBDE-153 significantly decreased FPG by 6.82% (95% CI: -12.50, -0.78). A doubling of PFNA and PFOS was associated with decreased FPG (-8.87% [95% CI: -17.57, 0.76], and -8.50% [95% CI: -16.71, 0.52], respectively). Persistent EDC exposure was not associated with GD or FPG  $\geq 5.1$  mmol/L. Discussion: Preliminary analyses suggest prenatal PCB exposure is associated with higher FPG among pregnant overweight women, whereas certain PBDEs and PFASs were inversely associated with FPG. Further analysis will account for EDC mixtures and repeated measures of FPG across pregnancy and postpartum.

## **P01.2160. Congenital Malformations and Trace Metals: A Case-Control Study from Lubumbashi, DR Congo**

Tony Kayembe-Kitenge

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**Abstract:** As part of the African 'Copperbelt', Southern Katanga (DR Congo) has been an area of intensive mining, resulting in widespread environmental contamination. This study was initiated to address concerns about the possible causation of birth defects by toxic metals. Neonates born with a visible birth defect (cases) were recruited by systematic reporting in Lubumbashi for 2 years; controls were normal neonates from the same maternity. Within 1 day after delivery, mothers were interviewed about medical/obstetrical history, socio-economic variables, personal habits, residence and occupation. Trace metals were measured by ICP-MS in maternal urine and venous blood, umbilical cord blood and placental tissue. Congenital malformations were characterized clinically and photographs. Associations between congenital malformations and metal concentrations and variables obtained from the questionnaire are being analysed by multivariate analysis. Overall, 138 cases and 108 controls were included. The two groups were well-matched with regard to potential confounders (maternal age, parity, socio-economic status). Mining-related jobs were more prevalent ( $p < 0.05$ ) among fathers of cases (17%) than controls (8%). In both cases and controls, trace metals in urine and blood were substantially higher than reference values from industrially developed countries. In preliminary analyses, manganese (Mn) appeared significantly higher in cord blood and placental tissue (fetal side) from cases. This is the first study to investigate the association between environmental pollution by mining-related activities and birth defects in sub-Saharan Africa. Preliminary analyses suggest father's work in mining and prenatal Mn exposure are associated with the occurrence of congenital malformations. Limitations of our study include a possible over-matching of cases and controls (controls were born in the same maternity as cases) and that biomonitoring data were obtained at delivery and not early in pregnancy.

## **P01.2170. Indoor Pesticide Exposure, Birthweight, and Gestational Age: A Cohort Study among Pregnant Women in Beijing, China**

Zeinab Farhat

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**Abstract:** Background: Prenatal exposure to pesticides are a major public health concern for adverse reproductive outcomes including birthweight. The association between pesticide exposure in pregnant women and fetal growth remains inconsistent. Objective: The aim of the present study was to evaluate the association between maternal exposure to indoor pesticides with infant birthweight and gestational age in a Chinese population. Methods: A total of 201 study participants in early pregnancy were recruited from Hangtian and Anzhen Hospitals in the Haidan District of Beijing, China. A baseline questionnaire collected information on demographics, disease history, occupational exposure and medical history. Mothers were asked if they use pesticides/insecticides in the home (yes/no). At follow-up, women reported the birthweight in grams and gestational age in weeks. We used linear regression to estimate the change in birthweight and gestational age related to reported indoor pesticide use. Results: Of the 201 participants, 114 women had information available for both indoor pesticide use and birth outcomes. A total of 19 participants (16.67%) reported indoor pesticide use during the 1st trimester. Birthweight ranged from 1100g-4600g and gestational age ranged from 29-41 weeks. The crude model showed a significant reduced birthweight for mothers exposed to indoor pesticides ( $\beta = -273.37$ ,  $p=0.04$ ). However, after adjustment for parity, smoking status, BMI, and maternal age, we observed no significant association between indoor pesticide use and birthweight ( $\beta = -248.71$ ,  $p=0.06$ ). Indoor pesticide use in the 1st trimester was associated with a significant decreased gestational age ( $\beta = -0.91$ ,  $p=0.04$ ) after adjustment for parity, infant sex, BMI, maternal age, and smoking status. Conclusions: Our results indicate that exposure to home pesticides use during the 1st trimester of pregnancy was associated with a decrease in birthweight and gestational age in this Chinese population.

## **P01.2180. Maternal Urinary Phthalate Concentrations, Gestational Diabetes, and Glucose Intolerance during Pregnancy**

Rachel Shaffer

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**Abstract:** Background/Aim: Recent studies have linked phthalates, among other endocrine disrupting chemicals, with type 2 diabetes. However, limited research exists on the potential association between phthalates and gestational diabetes (GDM) or impaired glucose tolerance (IGT), defined as a failed glucose challenge test but normal glucose tolerance test, during pregnancy. Methods: We evaluated 11 urinary phthalate metabolites from the first (T1) and third (T3) trimesters of pregnancy and medical record abstraction data in 674 women from The Infant Development and Environment Study. We used logistic regression to examine the associations between log-transformed and specific gravidity adjusted T1-only and average phthalate metabolite concentrations across pregnancy (mean of T1 and T3) with GDM and IGT. We adjusted for maternal age, maternal body mass index, study center, race/ethnicity, and parity. Results: We observed 58 cases of GDM and 66 cases of IGT within the cohort. Average mEP across pregnancy was associated with increased risk of GDM (OR: 1.94; CI: 1.12, 3.39). Other models suggested possible associations of other phthalate metabolites with GDM and IGT but were not statistically significant in the final analysis. Conclusions: Average mEP across pregnancy was associated with increased risk of GDM in this prospective cohort study. Given the prevalence of phthalate exposures and the growing evidence of their potential metabolic effects, future studies should examine this question in larger cohorts of pregnant women, particularly those who may be at higher risk for GDM and IGT.

**P01.2190. Vaginal Douching as a Possible Source of 1,4-Dichlorobenzene among Reproductive-Aged Women: National Health and Nutrition Examination Survey 2001-2004**

Ning Ding

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Abstract: Chronic exposure to volatile organic compounds (VOCs) contributes to adverse health effects in humans. No previous study has examined the use of feminine hygiene product as a potential source of VOCs. Several scientists and interest groups are calling for more research to fill in the gaps. Data on 2,432 women aged 20-49 years from NHANES 2001-2004 were used. We examined the associations between self-reported use of feminine products (tampons, sanitary napkins, vaginal douches, feminine spray, feminine powder, feminine wipes/towelettes, and other products) with whole blood concentrations of VOCs. Concentrations were log-transformed to ensure normality. We utilized a directed acyclic graph to identify a minimal adjustment set to account for confounding. Multivariate linear regression models with complex survey design were used to estimate percent changes in VOC concentrations and 95% confidence interval (CI). Black women had a significantly more use of vaginal douching, and significantly higher whole blood concentrations of 1,4-dichlorobenzene ( $P < .0001$ ). After adjusting for age, race/ethnicity, educational attainment, income-to-poverty ratio, body mass index, pregnancy status, and menopausal status, we observed a dose-response relationship between a frequency of vaginal douching in the past 6 months and 1,4-dichlorobenzene ( $P\text{-trend} = 0.04$ ). Compared to never users, women with occasional use ( $\geq 1/\text{month}$ ) of vaginal douching had 18.1% (95%CI: -12.0%, 58.7%) higher concentrations, and those with frequent use ( $\geq 2/\text{month}$ ) had 81.0% (95%CI: 2.2%, 220.8%) higher concentrations of 1,4-dichlorobenzene. Use of feminine powder in the past month was also significantly associated with 35.6% (95%CI: 0.4%, 83.2%) higher concentrations of ethylbenzene. The presence of environmental chemicals contained in feminine hygiene products warrants further examination with longitudinal designs and repeatedly-collected samples.

## **P01.2220. Mediation of the Association between Prenatal Arsenic Exposure and Infant Birth Outcomes by DNA Methylation of DNMT3A**

Anne Bozack

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**Abstract:** Background: Prenatal arsenic (As) exposure is negatively associated with birth weight and gestational age. Epigenetic changes, including DNA methylation (DNAm) play a critical role in fetal development. DNA methyltransferase 3 alpha (DNMT3A) is a key enzyme responsible for de novo DNAm and genomic imprinting. Thus DNMT3A is a prime candidate gene as a mediator between the prenatal environment and adverse birth outcomes. We evaluated the relationships between prenatal As exposure, gestational age (GA), birth weight (BW), and DNAm of DNMT3A. Methods: In a prospective Bangladeshi birth cohort, cord blood DNAm of three DNMT3A CpGs was measured using bisulfite pyrosequencing. Maternal toenail As concentration at birth was measured using inductively coupled plasma mass spectrometry to estimate fetal exposure. Among vaginal births (N=415), structural equation models (SEMs) were used to evaluate mediation by DNMT3A DNAm for the association between log<sub>2</sub>-maternal toenail As concentration, GA, and BW. Results: DNAm of the three CpGs was used to define a latent variable representing DNMT3A. In an unadjusted SEM, the effect of As concentration on BW was mediated by GA (indirect effect  $\beta=-0.02$  P=0.007). Arsenic concentration was positively associated with DNAm of DNMT3A (P=0.002). DNMT3A DNAm mediated the association between As concentration and GA ( $\beta=-0.05$ ; P=0.02), but not the association with BW. Overall, results adjusted for infant sex and maternal weight gain and education were consistent. DNAm mediated the association between As concentration and GA ( $\beta=-0.04$ ; P=0.02); mediation of the association between As concentration and BW by DNAm was borderline significant ( $\beta=-0.01$ ; P=0.06). In both unadjusted and adjusted models, the total effect of a doubling in As concentration was a decrease in GA of 2 days. Conclusions: DNMT3A plays a critical role in fetal epigenetic programming and may mediate the association between prenatal As exposure and birth outcomes.

## **P01.2230. Effect of In Utero Arsenic Exposure on Infant Birth Outcomes: Mediation by DNA Methylation of Cord Blood**

Anne Bozack

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**Abstract:** Background: In utero exposure to arsenic (As) is associated with adverse birth outcomes; this relationship may be mediated by epigenetic dysregulation. We evaluated the association between maternal prenatal As exposure, gestational age (GA), and birth weight (BW), and mediation by DNA methylation (DNAm). Methods: In a prospective birth cohort of pregnant women in Bangladesh exposed to As mainly through drinking water, maternal drinking water As was measured at  $\leq 16$  weeks GA, and toenail As was measured at  $< 1$  month postpartum. In a discovery phase, DNAm in cord blood was measured using the Infinium 450K array (N=44). In a validation sample of participants of the same cohort (N=570), cord blood DNAm was measured using bisulfite pyrosequencing for candidate CpG in miR124-3 (cg20277905), GNAL (cg06522054), and MCC (cg24937280) genes. Results: In the discovery phase, maternal water As was associated with DNAm of 396 CpGs ( $P < 1.10 \times 10^{-6}$ ;  $|\beta$  regression  $| > 0.10$ ). These CpGs were evaluated for associations with birth outcomes; 139 were associated with GA and one with BW ( $P < 0.05$ ). The main principal component of the top-ten CpGs fully mediated the inverse association between maternal prenatal water As and GA in a structural equation model (SEM) ( $P < 0.001$ ) but not for BW. In the validation phase, DNAm of miR124-3 and MCC mediated the association between maternal toenail As and GA (miR124-3  $P = 0.003$ ; MCC  $P = 0.006$ ). In an adjusted SEM including miR124-3 and MCC, the association between As and GA was mediated by DNAm of miR124-3 but not of MCC (miR124-3  $\beta = -0.04$ ;  $P = 0.02$  MCC  $P = 0.23$ ). Conclusions: miR124-3 is a microRNA coding gene that may be involved in embryonic growth, and in mouse models prenatal As exposure has been associated with miR124-3 expression. Using a discovery and validation approach, we show that DNAm of miR124-3 may mediate the association between prenatal As exposure and GA.

**P01.2240. Maternal Blood Cadmium Concentrations and Whole Blood DNA Methylation during Pregnancy in the Early Autism Risk Longitudinal Investigation (EARLI)**

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**Abstract:** Background: During pregnancy, the maternal epigenome may be responsive to environmental exposures. We tested whether maternal exposure to cadmium (Cd) results in differential maternal whole blood DNA methylation (DNAm) in early pregnancy. Methods: Maternal blood samples were collected at the initial study visit (during trimesters one or two of pregnancy) from 232 participants in the Early Autism Risk Longitudinal Investigation (EARLI) pregnancy cohort. We measured maternal blood Cd (n=215) using inductively coupled plasma mass spectrometry, which reflects recent exposure (blood t<sub>1/2</sub> ~75 days), and measured maternal blood DNAm (n=201) on the Illumina 450K array; 93 non-smoking women had both measures available for analysis. Linear regression was used to test for site-specific associations between blood Cd and DNAm, adjusting for cell type composition and confounding variables. Results: The distribution of blood Cd was right skewed and log-transformed for statistical analyses. The geometric mean of blood Cd was 0.2 µg/L (Interquartile range = 0.13 µg/L). An interquartile range difference in blood Cd was associated with a 13.1% increase in B-cell proportions (95% CI: 1.0 - 25.2). In multivariable regression, six CpG sites were associated (p-value<10<sup>-5</sup>) with log blood Cd concentrations. At five of these sites, increasing blood Cd was associated with hypermethylation, and three corresponded to the genes LYN, TESC, and ESD. The CpG site near LYN was closest to genome-wide significance (p-value = 1.9x10<sup>-6</sup>), and an interquartile range difference in blood Cd was associated with an 8.4% increase in percent methylation at this site (95% CI: 5.1 - 11.6). Conclusion: We report site-specific associations between DNAm and blood Cd in early pregnancy. Future work will consider the persistence of DNAm marks. Identified sites may be potential biomarkers of Cd exposure that can inform future epidemiological studies or implicate downstream gene pathways affected by Cd exposure.

**P01.2250. Breastfeeding as a Predictor of Serum Concentrations of Per- and Polyfluorinated Alkyl Substances in Reproductive-Aged Women and Young Children: A Rapid Systematic Review**

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**Abstract:** Background: Per- and polyfluorinated alkyl substances (PFASs) are ubiquitous, synthetic chemicals widely detected in human serum and breast milk. Objective: We conducted a rapid systematic review to assess the association between breastfeeding practices and serum concentrations of PFASs among reproductive-aged women and young children. Methods: We searched PubMed and Scopus for human studies that measured breastfeeding behavior and evaluated their associations with serum PFASs concentrations in women and children. We evaluated each study for the risk of bias (internal validity), and assessed the overall quality and strength of the evidence following the Navigation Guide systematic review approach. Results: We identified 14 relevant studies. Longer breastfeeding duration was significantly associated with increased serum concentrations of PFASs among infants/toddlers. Previous breastfeeding duration was significantly associated with lower serum concentrations of PFASs in pregnant and/or postnatal women. Specifically, children had 1-3% lower serum perfluorooctanoic acid (PFOA) concentrations and women had 4.7-6.0% higher serum PFOA concentrations, per month of breastfeeding. The overall risk of bias was rated as "probably low risk," and the body of evidence was rated as "high" and "moderate" quality for studies that assessed women and children, respectively. Conclusion: We conclude there is "sufficient" evidence supporting an association between breastfeeding and serum PFASs concentrations among women, but "limited" evidence of an association among children due to limited sample size and potential bias from confounding and exposure misclassification. These findings reinforce that lactation is an important excretion route of PFASs for women, and that breast milk may be an important exposure pathway for young children. Future studies should further investigate the implications of our findings for maternal and child health.

**P01.2260. Associations of Serum Perfluoroalkyl Substance and Vitamin D Biomarker Concentrations in the National Health and Nutrition Examination Survey (NHANES), 2003-2010**

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Abstract: Perfluoroalkyl substances (PFAS) are persistent endocrine disrupting chemicals found in industrial and commercial products. Previous research has shown that other endocrine disrupting chemicals such as phthalates and bisphenol A may alter circulating levels of vitamin D; however, no research has examined associations between PFAS and vitamin D biomarkers. We conducted a cross-sectional analysis of 7,040 individuals aged 12 years and older participating in the 2003-2010 cycles of the United States National Health and Nutrition Examination Survey (NHANES). Concentrations of four PFAS and total 25-hydroxyvitamin D [25(OH)D] were measured in serum samples. We used multivariable linear regression to estimate covariate-adjusted differences in total 25(OH)D per log 10-unit increase in PFAS concentrations. We assessed potential effect measure modification by gender, age, and race/ethnicity in stratified models. PFAS were detected in over 98% of the samples. After adjusting for confounders, a 10-fold increase in perfluorohexane sulfonic acid was associated with a 2.6 nmol/L increase (95% CI: 1.0, 4.2) in total 25(OH)D. Age, gender, and race/ethnicity did not modify this association. A 10-fold increase in perfluorooctane sulfonic acid was associated with a 2.8 nmol/L decrease (95% CI: 0.6, 4.9) in total 25(OH)D, with associations significantly stronger among whites ( $\beta$ : -5.3; 95% CI: -8.4, -2.3) and individuals older than 60 years of age ( $\beta$ : -5.8; 95% CI: -9.7, -1.8). Other PFAS were not associated with total 25(OH)D. Our results suggest that some perfluoroalkyl substances may be associated with altered vitamin D levels in the United States population, and associations may vary by chemical, age, and race/ethnicity.

**P01.2270. Association of Prenatal Exposure to Benzophenone-3 with Cognitive Function in 4.5-Month-Old Infants**

Francheska Merced-Nieves

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Abstract: Benzophenone-3 (BP-3) is typically found in sunscreen and cosmetic products to protect skin from sun damage. However, its effects on human health, including neurodevelopment, are largely unknown. We assessed the association between prenatal BP-3 exposure and performance on a physical reasoning task in 105, 4.5-month-old infants from an ongoing prospective pregnancy study in Illinois of mostly white (88%) women with 84% having at least a college education and 77% having a household income above \$50,000. Five first morning urines collected across pregnancy were pooled and we quantitated BP-3 in the pooled sample to estimate average BP-3 concentration in pregnancy. Concentrations of BP-3 in maternal urine were substantially higher (median [IQR]=123[324]) than concentrations reported in the National Health and Nutrition Examination Survey (median [95% CI] = 20[16-25]). Infants' looking time to two events - one physically impossible and the other possible - was recorded via infrared eye tracking. Infants who understand an event is impossible typically look longer at it than a possible event, with infant girls generally doing better than boys. Multivariable generalized linear models were used to examine the association of urine BP-3 with the difference in looking time between the two events (impossible - possible) adjusted for urine specific gravity, child sex, age, breastfeeding, household income, maternal education, and order of event presentation. Each interquartile range (IQR) increase in BP-3 was associated with a 622 msec decrease (95% CI: -40, -1204) in looking time difference score. Infant sex or event order did not significantly modify BP-3 associations. Findings suggest that higher prenatal BP-3 urine concentrations are associated with poorer physical reasoning at 4.5 months of age in both boys and girls, despite sexual dimorphism of the task. This result needs corroboration in a large sample. ES007326, ES022848, RD83543401, OD023272.

## **P01.2280. Serum-Adipokine Hormones from Birth to Puberty in Children Exposed to Perfluoroalkyl Substances**

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**Abstract:** Background: Early life exposure to perfluoroalkyl substances (PFASs) has been associated with low birth weight and deviations in growth outcomes in children. Animal studies suggest these associations are mediated by PFAS interference with adipokine hormone regulation, but human data are limited. Aim: To evaluate the associations of early life PFAS exposures with adipokine hormone levels at birth and postnatally. Methods: We examined 80 mother-child pairs from a Faroese cohort born in 1997-2000. We measured 5 major PFASs in late pregnancy maternal serum and child serum at ages 5, 7 and 13 years. We used multivariable-adjusted regression models to assess the cross-sectional/prospective associations of PFASs (log<sub>2</sub>) with concentrations of 3 adipokines (ln-transformed, ng/mL) in cord blood and child serum at later ages. Results: Low to high correlations were seen for PFAS pairs within ( $0.09 \geq r \leq 0.83$ ) and between ( $0.15 \geq r \leq 0.74$ ) ages. Leptin showed mainly inverse associations that were significant for the cord blood concentrations with maternal serum PFOA ( $\beta$ [95%CI] per exposure doubling = -0.91[-1.71,-0.11]), leptin at ages 5 and 13 and maternal PFHxS, and for leptin at all postnatal ages and child serum-PFOS at previous/outcome ages. Cord blood adiponectin was associated with maternal serum concentrations of all PFASs, except PFOA (e.g.  $\beta$ [95%CI] per PFHxS doubling = -0.32[-0.63,-0.01]), while associations for postnatal adiponectin and child serum-PFASs were of smaller magnitude. Lower cord blood resistin was associated with maternal PFDA, and lower resistin at ages 5-13 was associated with child serum PFOS, PFOA and PFNA at previous/outcome ages. We found patterns of stronger inverse associations with leptin and adiponectin in girls, but stronger inverse associations with cord blood resistin in boys ( $p$ -sex interactions < 0.10). Conclusion: This study suggests potentially sex-specific associations of PFAS exposures with adipokine hormone levels at birth and throughout childhood.

## **P01.2290. Impact of In Utero and Adolescent Phthalate Exposure on Sexual Maturation Progression**

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Abstract: Phthalates are endocrine disrupting compounds commonly found in consumer products, exposure to which may influence reproductive maturation in adolescence. Differential effects from exposure in utero versus later in life are understudied. We examined sex-stratified longitudinal associations between the geometric mean of 3 trimester-specific spot urine phthalate measurements and sexual maturation at two points in adolescence (8-14, 9-18 years), as well as cross-sectional associations at 9-18 years. Sexual maturation was assessed using Tanner stages and menarche onset for girls (N=246) and Tanner stages and testicular volume for boys (N=226). Generalized estimating equations for correlated ordinal multinomial responses were used to model relationships between phthalates and odds of transitioning to the next Tanner stage, while generalized additive (GA) mixed models were used to assess the odds of menarche. Cross-sectional analyses employed GA models (female N=281; male N=264). Among girls, MEP in utero exposure was associated with increased odds of being at a higher Tanner stage for breast development at 8-14 years, but with slower progression of breast development over the follow-up period (OR=0.74 per year; 95% CI: 0.57, 0.96) after adjustment for child age, BMI z-score and time between study visits. Similar results were found for breast development with in utero exposure to MEOHP, MBzP, and MCP. There were no significant associations of in utero exposures with pubertal stage among boys, but concurrent MEP exposure was associated with lower odds of progression of genital development (OR=0.87; 95% CI: 0.76, 0.99). These results suggest in utero exposure to phthalates may disrupt estrogenic pathways to impact breast development during puberty, and that exposure results in earlier onset but slower progression of sexual development. In addition, MEP exposure during late adolescence may impede genital development among boys.

## **P01.2300. Perfluoroalkyl Substances and Birth Outcomes: A Pool Analysis in the Danish National Birth Cohort**

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**Abstract:** **BACKGROUND:** Perfluoroalkyl substances (PFASs) are widespread persistent organic pollutants. Animal studies indicated that in-utero PFAS exposure may affect fetal growth, but human studies findings are inconclusive. Few human studies evaluated adverse birth outcomes primarily due to small sample size. **METHODS:** We conducted a pooled analysis using data of 3,535 mothers and infant pairs from three sub-samples originating from the Danish National Birth Cohort (DNBC), with 1398, 545, and 1592 mutually exclusive births respectively. All sub-samples have first trimester maternal plasma concentrations of PFOS and PFOA, and 4 additional PFAS (PFHxS, PFNA, PFHpS and PFDA) were available in sub-sample 2 and 3. PFAS measures were analyzed as continuous variables after natural-log (LN) transformation or categorized into tertiles. We estimated changes in birth weight (grams) or gestational age (days), odds ratios (OR) and 95% confidence intervals (CI) for infants born preterm (< 37 gestational week) or low birth weight (< 2500 gram). Potential confounders were included, and sampling weights of each sub-sample were accounted in statistical analyses. **RESULTS:** We estimated that each LN-ng/ml increase in PFOS, PFOA and PFHpS was associated with a 64g, 51g or 55g decrease in average birth weight. Several PFASs (PFOS, PFNA, and PFHpS) were also associated with a small decrease in gestational age at delivery. Moreover, we estimated elevated ORs for PFOS and PFHpS and low birth weight and preterm. For instance, OR for low birth weight and preterm were 1.7 (95% CI 0.9, 3.2) and 2.0 (95% CI 1.2, 3.2) respectively comparing the highest to the lowest exposure tertile. **CONCLUSION:** Our pooled analyses demonstrated that several prenatal PFASs are inversely associated with birth weight and gestational age, and prenatal PFOS and PFHpS exposure may affect the risks of being born low birth weight and preterm. Our findings strengthen the evidence that in-utero PFAS exposures may affect fetal growth.

## **P01.2310. Multi-Sources Exposure to Pesticides during Pregnancy and Risk of Hypospadias and Cryptorchidism: The French National Birth Cohort Elfe**

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**Abstract:** Prenatal occupational exposure to pesticides has been associated to male reproductive tract abnormalities. Exposure of the general population might occur through other sources (domestic uses, diet and living proximity to crops) but little is known on the developmental effects of non-occupational exposure. We aimed to assess the association between this multi-sources exposure to pesticides during pregnancy and the risk of hypospadias and cryptorchidism. Among the 9,059 boys of the French birth cohort Elfe, 51 were diagnosed with hypospadias and 134 with cryptorchidism. Exposure was assessed from 1) self-reported domestic uses of 8 pesticide product types, 2) acreage within a 1000m-buffer around home for 11 crops using French spatialized data of soil occupancy and agricultural register, and 3) maternal daily intakes estimated from food-frequency questionnaire and national survey data for 60 pesticide residues in food. For each exposure source, due to high number of variables, best-predictors selection procedure (Elastic Net) was firstly used. We then used logistic regression to assess simultaneously associations for the multiple selected exposure sources, accounting for confounding. Multiple imputation was used to handle for missing data. An increased risk of hypospadias was observed in association with domestic uses against fleas and ticks (OR=1.58, 95% CI: 1.10;2.23), with acreage of barley within the 1000m-buffer around home (1.69, 1.17;1.44), and with dietary intakes of  $\lambda$ -cyhalothrin (2.09, 1.11;3.95). For cryptorchidism, an increased risk was associated with the acreage of miscellaneous cereal crops within the 1000m-buffer (1.59, 1.04;2.41). No association was observed with domestic uses nor with dietary exposure. Using population-based cohort, our results suggest a possible increased risk of hypospadias and cryptorchidism in association with prenatal exposure to pesticides from some dietary and residential sources. This work is limited by a modest number of cases.

**P01.2330. Gestational Perfluoroalkyl Concentrations and Thyroid Hormone Levels in Faroese Pregnant Women and Neonates: A Prospective Cohort Study**

Christina Xiao

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**Abstract:** Background: Exposure to perfluoroalkyl substances (PFASs) may disrupt maternal and neonatal endocrine function. Adequate thyroid hormone (TH) levels during pregnancy are essential for fetal and early childhood development. Objective: To assess the relationship between gestational PFAS exposures and maternal and cord TH levels. Methods: Data was collected from a cohort of 182 mother-child pairs from 1994-1995 in the Faroe Islands. The concentrations of 17 PFASs, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were measured in maternal serum. Maternal and cord serum were measured for THs such as thyroid stimulating hormone (TSH), free thyroxine (FT4), thyroxine (T4), free triiodothyronine (FT3), free triiodothyronine resin uptake (T3RU), and free T4 index (FTI). We examined relationships between PFAS concentrations and TH levels using multivariable regression models and effect measure modification in sex-stratified analyses. Results: PFAS concentrations were mostly positively associated with both maternal and fetal TSH. PFOS and PFOA had the strongest estimates; doubling PFOS and PFOA concentrations were associated with 49% (95% CI: 18, 87%) and 33% (95% CI: 11, 59%) increase in cord TSH concentrations respectively. Perfluorooctanesulfonamide (PFOSA) was negatively associated with maternal FT4 and T3RU but positively associated with cord T4 and FTI levels. In mothers carrying female fetuses, doubling PFOS concentrations was associated with a 54% (95% CI: 14, 109%) increase in maternal TSH, but not in mothers bearing male neonates (-5%; 95% CI: -27, 24%). We did not observe consistent patterns for sex-stratified associations between gestational PFAS concentrations and cord TH levels. Conclusions: Prenatal exposure to several PFASs during pregnancy, such as PFOS and PFOA, is associated with increases in infant TSH levels. PFOS may also affect maternal TSH levels depending on the fetus's sex, the implications of which are still to be understood.

**P01.2340. Association between Serum Anti-Diphtheria Toxoid Antibodies and Drinking Water Arsenic Exposure in a Prospective Birth Cohort in Rural Bangladesh**

Barrett Welch

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**Abstract:** Background. There is evidence that arsenic exposure in early life modulates humoral immunity. Objective. We examined the association between drinking water arsenic concentrations to diphtheria vaccine-antibody concentrations measured at age 5. Methods. A prospective cohort of pregnant women was recruited in Bangladesh (2008-2011). Drinking water arsenic was measured at  $\leq 16$  weeks gestation,  $< 1$  month birth, between ages 20 to 40 months, and between ages 4 to 5 years, in a total of 510 children. Serum was collected from children at age 5. Concentrations of anti-diphtheria toxoid IgG antibody were quantified using enzyme linked immunosorbent assays. Antibody concentrations below 0.1 IU/mL were considered insufficient for long-term clinical protection. Linear and logistic regression models assessed the association between vaccine antibody and arsenic concentrations. Results. We found negative associations between arsenic exposure and concentrations of vaccine antibodies. The largest effects occurred with exposures measured during the in utero and neonatal periods. A 1-unit increase in natural log maternal water arsenic at  $\leq 16$  weeks gestation was associated with 9.9% greater odds of insufficient clinical titers of anti-diphtheria antibody compared to being clinically protected (Odds Ratio(OR): 1.10, 95% confidence interval(CI): 1.00, 1.21). After adjusting for paternal income, maternal education, breastfeeding duration, birth type, sex, child age, and BMI at blood draw, this association was attenuated where a 1-unit increase in natural log maternal drinking water arsenic at  $\leq 16$  weeks gestation was associated with a 4.3% greater odds of insufficient clinical titers of diphtheria antibody compared to being clinically protected (OR: 1.04, CI: 0.93, 1.17). Conclusion. This study provides preliminary evidence early life arsenic exposure is associated with a decreased likelihood of clinically protective levels of serum antibody to diphtheria, despite appropriate immunization.

## **P01.2350. The Paraquat Exposures of Pregnant Women and Neonates in Agricultural Areas in Thailand**

Pajaree Konthonbut

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Abstract: Although banned in over 50 countries, paraquat is a widely used herbicide in Thailand. Animal studies have found developmental impacts from fetal exposures, but there is no human data on potential fetal exposures among agricultural workers. This study recruited 79 pregnant women from three hospitals in agricultural areas in Thailand, and assessed paraquat concentrations in the urine of the women at 28 weeks of pregnancy, delivery and 2 months postpartum. Paraquat levels were also measured in the meconium of neonates. The subjects were interviewed about personal characteristics, agricultural activities and pesticide use patterns. The geometric mean (GSD) urinary paraquat concentrations at 28 weeks of pregnancy, delivery and 2 months postpartum were 2.04 (4.22), 2.06 (5.04) and 2.42 (5.33) ng/ml, respectively. The geometric mean (GSD) paraquat concentration in meconium was 33.31 (4.59) ng/g. There were no significant differences in urinary paraquat concentrations at 28 weeks of pregnancy, delivery and 2 months postpartum or in meconium levels between those whose self-reported occupation was agriculturist compared to those in non-agricultural occupations. However there were significant differences in paraquat exposures for those who reported agriculture related activities including: working outside, living near farmland where pesticides are sprayed, having a family member who is an agriculturist, drinking well water, or use of herbicides or use of paraquat by the pregnant woman or a family member.

**P01.2360. Parental Occupational Exposure to Potential Endocrine Disrupting Chemicals, Adverse Birth Outcomes, and Effects of Multi-Vitamin Supplements**

Huanhuan Zhang

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**Abstract:** Objectives: To assess the combined effects of maternal and paternal occupational exposure to EDCs on adverse birth outcomes, and further explore if folic acid and multi-vitamin supplements modified the effects. Methods: In a prospective study from Dec 2011 to Dec 2014 in Guangzhou, China, a total of 5734 parent-child pairs were included. Questionnaire designed according to job exposure matrix (JEM) was applied to collect parental occupational EDCs exposure history. We performed logistic regression to estimate the associations between parental EDCs exposure and adverse birth outcomes including preterm birth (PTB), term low birth weight (LBW), birth defects and congenital heart disease (CHD), and further explored whether the associations differed by maternal folic acid and multi-vitamin supplement during pregnancy. Results: Maternal exposure to EDCs was associated with increased risk of birth defects (aOR=1.55, 95% confidence interval (CI): 1.05-2.38), exposure for more than 1.5 years and direct exposure increased this association, the aOR and 95% CI were 2.72 (1.53-4.86) and 2.12 (1.27-3.56), respectively, the effect was stronger among those without using multi-vitamin during pregnancy (aOR=2.35, 95%CI: 1.16-4.72) (Interaction P<0.05). Maternal EDCs exposure for more than 1.5 years and direct exposure increased risk of CHD, the aOR and 95% CI were 2.85 (1.43-5.66) and 2.35 (1.31-4.22), respectively, the risk was also higher among those without multi-vitamin supplements (aOR=2.57, 95%CI: 1.13-5.82) (Interaction P<0.05). Paternal occupational EDCs exposure was associated with increased risk of term LBW (aOR=1.89, 95%CI: 1.02-2.39); this risk was higher among mothers who not using multi-vitamin supplements (aOR=1.35(95%CI:1.01-1.79) (Interaction P=0.03). Conclusion: Maternal EDCs exposure is associated with birth defects and CHD while paternal exposure is associated with term LBW. These associations were slightly higher among mothers without multi-vitamin supplements.

## **P01.2370. Prenatal RFR Exposure and Cognitive Development of 5-Year-Old Children**

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**Abstract:** Background There is a growing global concern about the potential harmful effects on human health as the use of cell phones and electronics increases dramatically. However, the health effects of children exposed to prenatal RFR (radiofrequency radiation) during pregnancy are not well known. The purpose of this study is to investigate the association between RFR exposure in the fetal period and cognitive development in 5-year-old children. Methods The subjects were 633 children aged 5-year-olds in the (MOCEH) cohort study. Of the 633 participants, 118 participated in the RFR exposure measurement using the personal exposure measuring device (EME-Spy100®, Satimo, France) before the birth of the child during the period 2007. 11. - 2010. 8. IQ for 5-year-olds was assessed using the Korean version of the Korean Intelligence-Revised Edition (K-WIPPSI-R). We estimated associations with a generalized linear model that adjusted for potential confounders. Gender, region, maternal education level, maternal occupation, maternal smoking and drinking, maternal IQ, average daily call time for children, cord blood lead were considered considered as confounding factors. Results The child's IQ was significantly higher for large urban residents than for industrial complexes, and most mothers (92.4%) used their mobile phones during pregnancy. The change in the child's total IQ with increasing non-phone RF index was -1.8, but not statistically significant (95%CI : -4.66, 1.08). Child's IQ tended to decrease with increasing RF indices, but not statistically significant. Conclusions We have not found evidence for a significant association between fetal RFR exposure and cognitive development in 5-year-old children. Acknowledgement This study was supported by the National Institute of Environmental Research and the IT R&D program of MSIP/IITP [2017-0-00961, Study on the EMF Exposure Control in Smart Society].

## **P01.2380. Dietary Exposure to Pesticides in Tannia in Pregnant Surinamese Women**

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**Abstract:** Background Suriname's (8.8 kg active ingredient/ha) neurotoxic pesticides use is among the highest Caribbean-wide. The Caribbean Consortium for Research in Environmental and Occupational Health is assessing exposure to selected pesticides in 1000 vulnerable mother/child dyads. Environmental assessments showed residues of prohibited endosulfan and lindane in tannia (*Xanthosoma brasiliense*). This study assessed dietary exposure to these pesticides in tannia. Methods An interviewer-assisted survey in 696 participants assessed body weight (BW) and consumption and intake rates (IRs) of produce. A preliminary deterministic non-cancer risk assessment and a sensitivity analysis were conducted using USEPA's reference doses (RfDs) for endosulfan and lindane. Tannia consumption-associated risk was determined using the hazard quotient (HQ). Results Tannia was the most frequently consumed leafy vegetable (89%); mean IR 0.028 kg/day (range: 0.001-0.531 kg/day). Mean BW: 72 kg (range: 34-138 kg). Average case scenario: Tannia critical IRs > actual IRs (7.8 kg/day for endosulfan, 0.9 kg/day for lindane), HQ < 1 and the levels of concern (LoCs) were 221x > for endosulfan and 26x > for lindane compared to detected pesticide residue levels. Worst case scenario (lowest BW, highest IR and highest pesticide residue level) for lindane: Tannia critical IR (0.3 kg/day) ~ actual IR; HQ > 1; LoC < highest detected pesticide residue level. Discussion Dietary exposure to endosulfan in tannia does not seem to pose a risk for adverse health effects, but exposure to lindane in tannia in the worst-case scenario potentially does. Since the current RfDs for endosulfan and lindane are based on non-neurotoxic endpoints, the risk assessment findings must be interpreted cautiously. Funding FIC/NIH R24TW009570, R24TW009561, U01TW010087-01, U2RTW010104

**P01.2390. Autism Spectrum Disorders in Catalonia, Spain: A New Population-Based Case-Cohort Study to Investigate Environmental Factors**

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**Abstract:** Background: Autism spectrum disorders (ASD) are neurodevelopmental disorders characterized by impaired social interaction, deficits in social communication and restricted, repetitive, and stereotyped behaviors. Studies conducted in Northern Europe and United States have estimated an ASD prevalence of 0.61% and 0.67% respectively. In Spain there is only one small epidemiological study conducted in the Canary Islands in 2012 that shown a prevalence of 0.61%. The aim of this study is to estimate the ASD prevalence in 2016 and the cumulative yearly incidence between 2010 and 2016 in children in Catalonia, Spain. Methods: We set up a population-based cohort that included all children between 0 and 18 years of age insured in the Catalan Health System between 2010 and 2016. We identified all ASD cases diagnosed between 2010 and 2016 from the registry of the Catalan Health System (named Minimum Basic Data Set) by the ICD-9 codes 299.0, 299.1, 299.8, and 299.9. We estimated the ASD prevalence for 2016 and the cumulative yearly incidence between 2010 and 2016 with the 95% confidence intervals based on Poisson error structure. Results: We estimated an ASD prevalence of 0.93% (95% CI 0.88, 0.98) in children from 0 to 18 years of age in Catalonia in 2016. The ASD prevalence was 0.76% (95% CI 0.67, 0.84) in boys and 0.17% (95% CI 0.10, 0.24) in girls, with a sex ratio 4.44-fold higher in boys than girls. The ASD incidence increased from 0.06% (95% CI 0.01, 0.10) in 2010 to 0.18% (95% CI 0.10, 0.26) in 2016. Conclusions: The estimated ASD prevalence of 0.93% was higher than the average estimate reported in previous studies in Europe or United States. The prevalence was higher in boys than girls, with a sex ratio similar to previous studies. We also observed an increasing temporal trend of the ASD incidence in recent years. This new case-cohort study on ASD will allow investigating the role of environmental factors in the origins of ASD.

## **P01.2400. Urinary Phthalate Metabolites in Relation to Children's Asthmatic and Allergic Symptoms in Shanghai**

Wenming Shi

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**Abstract:** **BACKGROUND:** Few studies can be found on phthalates exposure in relation to childhood asthma and allergic symptoms from mainland of China, where a persistent increase of childhood asthma and allergic disease has been observed. **OBJECTIVES:** We aimed to find out the exposure levels of phthalates and its relationship with children's asthmatic and allergic symptoms in Shanghai. **METHODS:** A follow-up study(2013-2014) in 434 children 5-10 years of age was completed, based on the China, Children, Homes, Health(CCHH) study(2011-2012). Asthmatic and allergic symptoms (wheeze, rhinitis, eczema) were collected by questionnaire and 10 phthalate metabolites were analyzed in morning urine samples. Multiple logistic regression was applied to estimate the associations between symptoms and phthalate metabolites controlling for demographics, family history of allergic diseases and other covariates. **RESULTS:** Nine out of 10 phthalate metabolites were detected in all subjects (average detection rate 93.2%). By multiple regression analyses, the 4th quartile of MnBP(reference: The 1st quartile) had the adjusted odds ratios(AOR) and 95% confidence interval(95%CI) by 2.48(1.15-5.37), 2.18(1.05-4.54) and 3.09(1.22-7.83) for wheezing, rhinitis and eczema, respectively, while MiBP for rhinitis and eczema by 2.31(1.12-4.73) and 2.95(1.05-8.51), respectively. MEHHP and MEOHP were significantly associated with eczema by 3.14(1.12-8.83) and 2.65(1.02-6.85), respectively. By summing up the 4 low molecular weight(MW) metabolites and all 9 metabolites, the 4th quartiles of the sums were significantly associated with all symptoms. Subjects with 2 or 3 concomitant symptoms(reference: no symptoms) had significant positive associations with most of the above phthalate metabolites. **CONCLUSIONS:** Low MW metabolites such as DnBP and DiBP, high MW of DEHP and the total amount of phthalate metabolites might have adverse health effects on asthma and allergic symptoms in Chinese children.

## **P01.2401. Associations of Maternal Pregnancy Urine Estrogen Levels with Phthalate and Phthalate Replacement (1,2-Cyclohexane Dicarboxylic Acid Diisononyl Ester, DiNCH) Metabolites**

Diana Pacyga

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**Abstract:** Rationale: Pregnant women are exposed to phthalates in food, personal care and household products. Phthalates alter estrogen levels in experimental models but their potential to impact levels in human pregnancy is not well characterized. Methods: 291 participants in an Illinois pregnancy cohort collected 5 urines across pregnancy for pooling and quantification of 16 phthalate/DiNCH metabolites. Exposures were expressed as the molar sum of metabolites for:  $\sum$ DiNCH,  $\sum$ DEHP,  $\sum$ DBP,  $\sum$ DiBP,  $\sum$ DiNP,  $\sum$ PCP, and  $\sum$ AA (respective personal care product and anti-androgenic phthalates). At 10-14, 28-30 and 34-36 gestational weeks (GW), urine estradiol, estrone, estriol and metabolites were measured and summed ( $\sum$ E). Specific gravity adjusted exposure and  $\sum$ E data were log-transformed. Linear mixed-effects models assessed relationships of phthalates/ $\sum$ DiNCH with  $\sum$ E controlling for fetal sex, maternal age, pre-pregnancy BMI,  $\sum$ E analytic batch, and GA at urine collection for  $\sum$ E evaluation. Interactions of phthalates/ $\sum$ DiNCH, fetal sex,  $\sum$ E batch, and GA at  $\sum$ E urine collection were explored. Results: Participants were 82% white, 72% had income >\$60,000/yr, 84% had a college+ education, and urine biomarker levels were similar to U.S. women. At 10-14 weeks,  $\sum$ E increased with increasing:  $\sum$ DBP (b=1.5, 95% CI=0.5, 2.5),  $\sum$ DiNP (b=1.3, 95% CI=0.6, 2.0),  $\sum$ PCP (b=0.5, 95% CI=0.1, 0.8), and  $\sum$ AA (b=0.4, 95% CI=0.01, 0.7); associations in late pregnancy were attenuated and non-significant.  $\sum$ E increased with increasing  $\sum$ DEHP in women carrying females (b=0.7, 95% CI=0.2, 1.3) and  $\sum$ DiBP in women carrying males for  $\sum$ E measured in only one analytic batch.  $\sum$ E was not associated with  $\sum$ DiNCH. Conclusions:  $\sum$ DBP,  $\sum$ DiNP,  $\sum$ PCP, and  $\sum$ AA phthalates were associated with higher gestational  $\sum$ E in early but not later pregnancy. For other phthalates, associations were only in small sub-group analyses. Whether pregnancy estrogen levels mediate associations between phthalates and pregnancy outcomes merits investigation.

## **P01.2402. Associations of Prenatal Exposure to Triclosan and Benzophenone-3 with Visual Recognition Memory in 7.5-Month-Old Infants**

Kelsey Dzwilewski

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Abstract: Triclosan (TCS) is used in personal care products as an antimicrobial agent and benzophenone-3 (BP3) is used in personal care products and plastics as an ultraviolet absorber. Due to their endocrine disrupting properties, prenatal exposure to these chemicals may affect brain development, but little is known about their effect on infant cognition. Prenatal exposure to TCS and BP3 and visual recognition memory (measured by novelty preference) were assessed in 177 7.5-month-old infants participating in a prospective study in Illinois, USA. Study mothers were mostly white (86%), with 88% having at least a college education and 75% a household income above \$60,000. In a pool of five first morning urine samples collected across pregnancy, we quantified (median[IQR]) TCS (14.1[63.1] µg/L) and BP3 (118.6[273.0] µg/L). Infrared eye tracking recorded infant looking time at a trial with two identical faces followed by trials in which the familiar face was paired with a novel face. General linear models were used to assess associations of each exposure biomarker (adjusted for urine specific gravity) with novelty preference (percent time looking at the novel face) adjusted for infant age, gestational age, birth weight, sex, assessment condition, household income, and maternal IQ and education. There were no associations of TCS or BP3 with novelty preference and no sex differences in associations. Each IQR increase in TCS was associated with a 0.10% decrease (95% CI: -0.49,0.29) in novelty preference, while each IQR increase in BP3 was associated with a 0.04% increase (95% CI: -0.38,0.47). Generalized additive models showed no evidence of nonlinear associations of either TCS or BP3 with novelty preference. This preliminary analysis found no evidence associating maternal prenatal urinary TCS or BP3 with infants' recognition memory at 7.5 months, but the results need to be confirmed in a larger sample. Acknowledgements: NIEHS ES007326, ES022848, ES028607, OD023272, USEPA RD83543401

### **P01.2403. Associations of In Utero Polybrominated Diphenyl Ethers (PBDEs) and Polychlorinated Biphenyls (PCBs) with the Mid-childhood Gut Microbiome**

Hannah Laue

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**Abstract:** Background: The gut microbiome is influenced by early-life exposures, but—despite potentially enormous implications for child health—it is understudied in environmental health. This pilot study, the first to explore the effect of in utero exposures on long-term development of the microbiome, examined the association between first trimester and perinatal exposure to PBDEs and PCBs and the mid-childhood gut microbiome. Methods: We measured metabolites of PBDE-47, -99, -100, and -153 and PCB-138, -153, and -180 in maternal plasma during the first trimester (n=18) and at delivery (n=25) using gas chromatography coupled with tandem mass spectrometry in women from Sherbrooke, Quebec who identified as white and ever breastfed the child subject. The structure of the mid-childhood (6-8 years) fecal microbiome was measured using 16S rRNA sequencing. Sequences were processed using QIIME and paired to operational taxonomic units (OTUs) using SILVA v128. To test for differences at the OTU level, we used the MiCAM algorithm, adjusting for delivery mode and socioeconomic status. Results: Higher first trimester PCB-153, -180, and  $\Sigma$ 3PCB blood concentrations were associated with a higher relative abundance of Propionibacteriales and Propionibacteriaceae in mid-childhood. Higher PCB-180 and  $\Sigma$ 3PCB were associated with higher relative abundance of Bacillales Family XI. Higher PBDE-99 exposure was associated with a decrease in uncultured bacteria within the Ruminococcaceae NK4A214 group and PBDE-47 was associated with differences in Ruminococcus 2, but the direction of the association varied by lower-level taxa. These OTU-level changes did not result in differences to within- or between-subject diversity. Exposures at delivery were not associated with differences in OTUs. Conclusion: Early-life exposure to PCBs and PBDEs was associated with differences in the mid-childhood gut microbiome. Larger studies are needed to confirm these results and explore health implications.

**P01.2404. Preterm Birth among Infants Exposed to In Utero Ultrafine Particle Emissions from Aircraft Engines near the Los Angeles International Airport**

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Abstract: Ambient air pollution is a known risk factor for adverse birth outcomes, but the role of ultrafine particles (UFPs) is not yet well understood. UFP emissions from aircraft are spread across large residential areas downwind of airports, possibly causing a considerable reproductive health burden. Birth certificate data from the California Department of Public Health was drawn from all births by mothers living in a 200 mi<sup>2</sup> area downwind of Los Angeles International Airport (LAX) in 2011 (n=16,268). These records were used to ascertain the presence preterm birth (PTB), as well as maternal covariate information. To assess in utero exposure to UFPs, we input geocoded maternal addresses into a novel geospatial UFP dispersion model that has been validated by extensive ground-level measurements near LAX. We used multiple logistic regression, regressing PTB (live birth < 37 weeks gestation) on UFP concentrations estimated from the dispersion model. We adjusted for maternal factors like age, educational attainment, and race/ethnicity. We further adjusted for measures of air pollution from other sources, like traffic, including PM<sub>2.5</sub>, nitrogen oxides, and surface ozone to isolate the role of aircraft-related UFPs. An interaction term between UFPs and maternal nativity was included in the model. Among this birth cohort, we found an 11% increase in odds (95% CI: 1.01, 1.22) of PTB per interquartile range of UFP exposure. When stratified by maternal nativity, no increase in PTB among infants of foreign-born mothers was detected (OR = 1.02, 95% CI: 0.90, 1.16) but was detected among infants of US-born women (OR = 1.19, 95% CI: 1.06, 1.32). Effect modification by nativity was borderline statistically significant (p = 0.04). We found increased exposure to aircraft-related UFPs was associated with an elevated risk of PTB, serving as evidence of the reproductive health effects of UFP exposures from aircraft emissions. However, this relationship appears to be modified by maternal nativity.

## **P01.2405. The Effect of Prenatal Bone Lead Concentrations on Prepulse Inhibition: A Prospective Study of Mexican Children**

Kale Kponee

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**Abstract:** Background: An important concern is the toxic legacy of prenatal lead exposure. During pregnancy, maternal skeletal bone lead from earlier exposures mobilizes and crosses placental barriers placing the developing fetus at risk for lead exposure and subsequent neurobehavioral deficits. Some of the neuronal circuits implicated in mechanisms of neurodevelopment can be probed with simple physiological behavioral paradigms, potentially serving as a neurobehavioral marker of toxicant exposure. One such measure includes pre-pulse inhibition (PPI), a sensorimotor gating process that can modify the acoustic startle reflex (ASR) under different behavioral conditions. PPI impairment has been associated with neurodevelopmental deficits in children such as ADHD and early psychosis. To our knowledge, no studies have examined the effect of prenatal lead concentrations on PPI in children. Objective: The objective of this study was to determine the effect of prenatal bone lead concentrations on PPI in Mexican children 8-17 years of age. Methods: In vivo maternal bone lead measurements were taken at four weeks postpartum at the mid-tibia shaft and the patella using a K-Shell X-ray fluorescence (K-XRF) instrument. PPI responses were recorded in an isolated clinical setting and eye blink responses were assessed using electromyography. We used ordinary least squares regression adjusted for relevant covariates to model the relationship between prenatal bone lead and PPI. Results: Mean  $\pm$  SD lead concentrations in tibia and patella were  $9.33 \pm 10.00$   $\mu\text{g/g}$ , and  $12.27 \pm 12.17$  respectively. In adjusted models, higher tibia bone lead significantly reduced PPI in children. Patella lead concentrations were independent of PPI. Conclusions: In this population of Mexican children, prenatal tibia lead concentrations were associated with impaired PPI. These results suggest that lead may disrupt PPI, which could be a biological indicator of neurodevelopmental deficits in children.

## **P01.2406. Intrauterine Exposure to Polychlorinated Biphenyls (PCBs) and Anogenital Distance in Israeli Newborns**

Eva Siegel

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**Abstract:** Polychlorinated biphenyls (PCBs) are widespread environmental contaminants due to their extensive past use, long-range transport and persistence in adipose tissues of humans and animals. Specific congeners exhibit structural similarities to steroid hormones. This raises concerns regarding the effects of exposure on reproductive development in neonates. Here, we examine associations between prenatal exposure to PCB congeners 118, 138, 153 and 180 and anogenital distance in a cohort of newborns in Israel. We measured serum concentrations of the four PCB congeners in 173 pregnant women presenting to the delivery room at Assaf Harofeh Medical Center. Mothers completed questionnaires on lifestyle and demographic variables. Birthweight, length, head circumference and anogenital distances were measured using a standard protocol. Regression models estimated associations between maternal PCB exposure and infant anogenital measurements, birthweight, birth length and head circumference, controlling for confounding variables. Mean penile width, anoscrotal length, and anopenile length were 11.04 mm [standard deviation (sd): 1.14 mm], 23.43 mm (sd: 3.58), and 44.58 mm (sd: 4.58 mm) in male infants (n=90); mean anoforchetall and anoclitoral distances were 14.34 mm (sd: 2.17 mm) and 34.23 mm (2.74 mm) in female infants (n=83). Mean maternal serum concentrations were 2.91 ng/ml (sd: 1.93), 4.50 ng/ml (sd: 3.04), 7.42 ng/ml (sd: 5.41), and 4.98 ng/ml (sd: 3.62) for PCB-118, 138, 153 and 180, respectively. Higher maternal concentrations of all four PCBs were associated with reduced anogenital distance measures in male infants but not in female infants. No associations were found between PCB exposure and birthweight, length and head circumference. These results are significant as anogenital distance is associated with male reproductive problems later in life; thus, there are implications for later life reproductive health.

## P01. Adult Health Effects of Environmental Exposures 1

### **P01.2410. Association of Cumulative Exposure to Heavy Metal Mixtures with Obesity and Its Comorbidities among U.S. Adults in NHANES 2003-2014**

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**Abstract:** Background: Some heavy metals have been associated with obesity and obesity comorbidities. The associations have typically been examined for individual metals. Objectives: We update our Environmental Risk Score (ERS), a summary measure to examine the risk of exposure to multi-pollutants in epidemiologic research, to evaluate the associations of cumulative exposure to a mixture of correlated heavy metals with obesity and its comorbidities including hypertension (HTN), and type-2 diabetes mellitus (T2DM) while accounting for high degree correlations and potential interactions among metal mixtures components. Methods: We examined blood and urinary measurements of 18 heavy metals among 9,537 adults in NHANES 2003-2014. We randomly split data into a training set for the construction of ERS (n=6,675) and a testing set for validation (n=2,862). ERS of heavy metal mixtures were computed for obesity using adaptive elastic-net (AENET) with 189 predictors including 18 main effects, 18 square terms, and 153 pairwise interactions of heavy metals. Regression analyses with complex survey designs were performed to assess the association of ERS with obesity and its comorbidities. Results: 8 main effects (BPb, BCd, BHg, UDMA, UMMA, UBa, UHg and UTI), 3 square terms (BCd, UCd and USb), and 7 pairwise interactions (BPb&UCd, BPb&UMMA, BPb&UU, UCd&UMMA, UDMA&UW, UPb&USb and UMMA&UCo) of heavy metals have been selected by AENET for construction of ERS of obesity-related heavy metal mixtures. The ERS was positively associated with waist circumference, body mass index, skinfold thickness and total body fat, independent of age, sex, race/ethnicity, education, smoking, physical activity and NHANES cycle ( $P_s < 0.05$ ). Positive associations of ERS with both HTN and T2DM have also been observed ( $P_s < 0.05$ ). Conclusions: Our study suggests the potential role of exposure to heavy metals mixtures as a contributing factor to obesity and its related chronic conditions such as hypertension and T2DM.

**P01.2420. Assessing the Relation between Plasma PCB Concentrations and Elevated Autistic Behaviour Using Bayesian Predictive Odds Ratios**

Brendan Bernardo

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Abstract: Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by impaired social communication and repetitive or stereotypic behaviours. In utero exposure to environmental chemicals, such as polychlorinated biphenyls (PCBs), may play a role in the etiology of ASD. We examined the relation between plasma PCB concentrations measured during pregnancy and autistic behaviours in children aged 3-4 years old in the Maternal-Infant Research on Environmental Chemicals (MIREC) Study, a pregnancy and birth cohort of 538 mother-infant pairs from Canada (enrolled: 2008-2011). We quantified the concentrations of 6 PCB congeners in plasma samples collected during the 1st trimester. At age 3-4 years, caregivers completed the Social Responsiveness Scale-2 (SRS), a valid and reliable measure of children's reciprocal social and repetitive behaviors and restricted interests. We examined SRS scores as both a continuous and binary outcome and calculated Bayesian predictive odds ratios for more autistic behaviour based on a latent variable model with a threshold SRS >60. We found very small and imprecise increases in the mean SRS score for the highest quartile of plasma PCB concentrations compared to the lowest quartile, but these were accompanied by larger increases in the odds of more autistic behaviour. For instance, an average increase of 0.7 [95%CI: -0.8, 2.3] in the mean SRS (Q4 versus Q1) for PCB138 translated to an odds ratio of 1.5 [95%CI: 0.9, 2.3]. In conclusion, we found some evidence that plasma PCB concentrations during pregnancy may be associated with small increases in autistic behaviours in this cohort. Our findings demonstrate the importance of measuring associations between PCBs and autistic behaviour on both continuous and binary scales.

## **P01.2430. Data Synthesize for Semantic Fine-Grained Prediction of Lung Nodule in CT Images**

Zhiqin Liu

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**Abstract:** Background/Aim Semantic terms of lung nodules such as lobulation, spiculation, malignancy, etc. can be commonly found in radiology reports to describe the semantic characteristics for diagnostic reference. The prevalence of malignancy among pulmonary nodules ranges between 0.2% and 50%. The main purpose of fine-grained prediction is to differentiate subordinate categories of the same semantic base classes and to provide an imaging biomarker with richer quantitative assessments of nodules for better prevalence estimation and diagnostic decision. Challenges Since some subtypes or stages of one disease are rare but important, significant data imbalance might present and render the prediction problem very arduous. Data imbalance could bias the learning frameworks and is essential in the popularization of data-hungry deep learning paradigms. However, this problem was not elaborated in previous works of lung nodules. Methods We explored the cutting-edge Wasserstein Generative Adversarial Networks (WGAN) to address the data imbalance issue with over-sampling on the minority classes and tested this method on the public Lung Imaging Database Consortium (LIDC) dataset. The WGAN can estimate the underlying distribution of a minority class to synthesize more plausible and helpful samples for the prediction model. Results The experiment shows that the proposed method improves F-measure by an average of 9.53% for the smallest minority classes compared to conventional method. It suggests that the WGAN technique can synthesize helpful samples for minority classes to assist the training of the Convolutional Neural Network (CNN) model and to boost fine-grained prediction performance. Conclusion More synthesized samples obtained by considering the underlying distribution of minority classes will benefit the prediction. Future work will explore the relation among semantic terms for the data synthesis to simplify the oversampling process as well as to boost the synthetic quality even further.

## **P01.2450. Identifying Geospatial Patterns of Aggressive Breast Cancer Incidence Using North Carolina State as a Model**

Larisa Gearhart-Serna

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**Abstract:** Breast cancer is a complex disease influenced by multiple factors, and overall survival improvements are hindered by aggressive and advanced cases that are not well understood. Our objective was to evaluate geographic variability in the prevalence of late stage metastatic breast cancer and total breast cancers in North Carolina. NC represents a state with geographic variability in cancer incidence, demographics, and environmental factors, making it an ideal location for this study. We collected breast cancer patient data from the North Carolina Central Cancer Registry for years 2009-2014, and derived summary staging was used to classify cases as in situ, localized, regional, or distant/metastatic. Total incidence data was averaged to reflect a 6-year incidence average. Age-adjusted standardized incidence ratios (SIRs) and 95% confidence intervals were then calculated for total breast cancer and distant/metastatic breast cancer for each county in NC. Prior studies have identified NC as part of a high breast cancer incidence region in the US, but there remains insufficient granular analysis such as the described methodology. We identified several counties in North Carolina with statistically significant high SIRs for breast cancer on the outer western and eastern regions of the state. For distant/metastatic breast cancers, statistically significant high SIRs were located primarily in the northeastern coastal region. We intend to investigate these counties further in correlation with environmental factors, including industry-derived, air, soil, and water contamination, and a variety of social, behavioral, and demographic factors. Overall our data identifies differential regions of NC with higher than expected incidence of total versus aggressive breast cancers, suggesting that different demographic or environmental factors may play a role in the observed variability. This work was supported by Duke Cancer Institute Cancer & Environment Funds and NIEHS T32-ES021432.

## **P01.2470. Possible Risks of High Altitude Exposure on Prostate Diseases**

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Abstract: More of 200 million people lives permanently over 2000 meter above sea level worldwide. In addition, a big proportion of the population in the world is exposed acute, intermittently and chronically to high altitude due to work, sports, tourism among others. From 5-20% of the population living at HA is diagnosed of EE (Hb>21 g/dl in men) and CMS. In Andean populations, this high production of erythrocytes has been associated with activation of gene SENP1, which in time is related to increased androgenic activity. Epidemiological study has demonstrated that OR for prostate cancer is increased at high altitude. A recent work from our laboratory showed that PSA levels were lower in men less than 40 years living at HA. Prostate cancer at sea level was associated to activation of the gene SENP1. According to these data is suggested that prostate cancer could be a risk for population with EE sharing elevated testosterone levels at HA. Interestingly, prostate disease at sea level and EE at HA share similar molecular and physiological mechanisms such increase of hypoxic induced factor (HIF), hematocrit (Hcto) and prostatic specific antigen (PSA). In addition, higher expression of the SUMO sentrin specific peptidase 1 (SENP1) is associated with higher androgen activity in Andean highlanders with excessive erythrocytosis (EE) and this expression promotes the development or progression of prostate cancer. Therefore, is important to perform a research to identify the existence of these factors in males with EE living at HA with the purpose of prevent and treat opportunely prostate diseases.

## **P01.2480. Indoor Tanning and the Risk of Developing Non-Cutaneous Cancers: A Systematic Review and Meta-Analysis**

Dylan O'Sullivan

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**Abstract:** Background: While, the relationship between indoor tanning and skin cancer is well established, the risk of developing a non-cutaneous malignancy from indoor tanning use is unknown. Given that sun exposure may protect against certain non-cutaneous cancer sites, perhaps through increased vitamin D production, it has been argued that indoor tanning could also be protective. However, radiation from indoor tanning devices is 10 to 15 times stronger than midday sun and primarily emits UVA rays, which are relatively ineffective at stimulating vitamin D synthesis. Methods: We conducted a systematic review and meta-analysis of case-control and cohort studies that investigated the association between indoor tanning and a number of non-cutaneous cancer sites. Associations were estimated using random effects models. Heterogeneity was investigated through subgroup analyses and the Q-test and I<sup>2</sup> statistics. Results: 15 studies examining 12 cancer sites were included. Control for sun exposure was a significant source of heterogeneity in the association of indoor tanning and non-cutaneous cancer risk (meta-regression  $p = 0.0043$ ). When restricting to studies that controlled for sun exposure (7 studies and 19 effect estimates) no association was observed among ever users of indoor tanning devices with the risk of solid non-cutaneous cancers (pooled relative risk = 0.98; 95% CI: 0.94-1.03), while a suggestive increased risk was observed among hematologic malignancies (pooled relative risk = 1.11; 95% CI 0.96-1.28). Neither study design (prospective cohort vs. case-control) nor geographic region (North America vs. Europe) were significant sources of heterogeneity. Conclusion: This is the first meta-analysis examining the risk of non-cutaneous cancers from the use of indoor tanning devices. Given the well-established relationship with skin cancer and potential relationship with hematologic malignancies, efforts to reduce the use of indoor tanning devices should continue.

**P01.2490. Temporal and Spatial Excess Leukemia Deaths Around the Nuclear Power Plant in Kyushu, Japan (1970-2005)**

Yumiko Miyano

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**Abstract:** Background/Aim Excess incidence of cancer including leukemia among people living in the vicinity of Nuclear Power Plant (NPP) in normal operation has been reported on from Germany, France, the United Kingdom, Korea, and others. But in Japan, any epidemiologic investigations have not been conducted yet while 18 NPP facilities have discharged radioactive substances e.g. tritium. 13 among 47 prefectures in Japan had NPPs until 2010, and 7 of them were ranked in top 15 leukemia mortality. We estimated the Standardized Mortality Ratios (SMRs) on leukemia of municipalities around the NPPs in Kyushu area, the western parts of Japan, and then summarized their temporal-spatial changes with using empirical Bayesian estimates. Methods We estimated leukemia SMRs with using data of age-sex specific five-year municipal population among 1965-2005 of Japanese Census, age-sex specific cause-specific leukemia deaths of Japanese Vital Statistics, and leukemia deaths of each municipalities. To adjust spatial variations of SMRs in the towns and villages with sparse population, we have applied empirical Bayes method with Poisson distribution model. Results SMRs of leukemia in the study region increased after beginnings of the operation of NPPs. The municipalities located the nearest to NPP had excess SMR (3.69: 95% CI, 3.11-5.56) comparing to farther areas of the prefecture. NPP Reactor type of the study areas was Pressurized Water Reactor (PWR) which released more radioactive substances comparing to Boiling Water Reactor (BWR). The study suggests the relationship between leukemia and NPPs normally operated in Japan.

## **P01.2510. Associations between Urinary Triclosan and Serum Thyroid Hormone Concentrations**

Julianne Skarha

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**Abstract:** Introduction: Exposure to the antimicrobial agent triclosan is ubiquitous. In animals, triclosan causes decreases in circulating thyroxine concentrations. However, the effects of triclosan on thyroid hormone levels in humans are unclear. Objective: To estimate the association of urinary triclosan concentrations with thyroid function and autoimmunity in women seeking assisted reproduction treatment in the Environment and Reproductive Health (EARTH) Study. Methods: The EARTH Study is a prospective preconception cohort that has been recruiting Boston area couples since 2004. We conducted a cross-sectional study of 318 EARTH Study women. At baseline, we quantified urinary triclosan concentrations using tandem mass spectrometry and serum thyroid hormone and antibodies levels using immunoassays. We estimated covariate-adjusted differences in thyroid hormones and antibodies with a 10-fold increase in urinary triclosan concentrations using linear regression. We examined effect modification by body mass index (BMI) and infertility diagnosis. We log-transformed thyroid-stimulating hormone, thyroperoxidase (TPOAb), and thyroglobulin (TgAb) and calculated percent differences. Results: Median urinary triclosan concentration was 8.4 µg/L (range: <3 - 2,397 µg/L). Each 10-fold increase in triclosan was inversely associated with free triiodothyronine (fT3) ( $\beta$ : -0.05 pg/mL; 95%CI: -0.1, -0.01), TPOAb (-9%; 95%CI: -18, 0), and TgAb (-12%; 95%CI: -23, 1). Triclosan was inversely associated with fT3 among women with a BMI <25 kg/m<sup>2</sup> ( $\beta$ : -0.08; 95%CI: -0.14, -0.03), but not among women with a BMI  $\geq$  25 kg/m<sup>2</sup> ( $\beta$ : 0.04; 95%CI: -0.04, 0.11) (BMI\*triclosan p-value = 0.03). Infertility diagnosis did not modify the association between triclosan and fT3 (p-value=0.98). Conclusion: Urinary triclosan concentrations were inversely associated with serum fT3, TPOAb, and TgAb concentrations in this cohort. Our findings, consistent with some prior studies, suggest that triclosan may affect thyroid homeostasis.

## **P01.2520. Metal Exposure as a Mixture and Intellectual Function in Adolescence in Bangladesh**

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**Abstract:** Background: Exposure to inorganic arsenic (As) is associated with modest deficits in intellectual function in young children. Few studies have examined associations in adolescence or whether co-exposure to other metals such as manganese (Mn), lead (Pb), cadmium (Cd), and selenium (Se) affects the association. Objective: We evaluated whether concurrent exposure to As (as creatinine-adjusted urinary As (UAs/Cr)), the afore-listed metals in blood, and maternal UAs/Cr at baseline, a proxy for peri-natal As exposure, were associated with adolescent intellectual function. Methods: The sample comprises 726 14-16-year-olds whose mothers are participants in the Bangladesh Health Effects of Arsenic Longitudinal Study (HEALS). We used a culturally modified version of the Wechsler Intelligence Scale for Children (WISC-IV) to measure Full Scale raw scores and Bayesian Kernel Machine Regression (BKMR) to investigate the joint effects of the metals mixture on these scores. BKMR uses a flexible kernel function to identify important mixture members while accounting for the correlated exposure structure, to estimate potentially nonlinear exposure-response functions, and to evaluate complex and potentially non-additive interactions. Results: Adolescent UAs/Cr, followed by Cd, were the two most important metals in the mixture, with posterior inclusion probabilities of 95.2% and 83.2%, respectively. Both adolescent UAs/Cr and Cd were significantly associated with decreased Full Scale scores. No significant interactions between metals were observed. The overall mixture (i.e., simultaneous exposure to all metals) was consistently significantly associated with decreased Full Scale scores. Conclusion: Our findings indicate that adolescent exposure to the metals mixtures, and predominantly to As and Cd, may be neurotoxic and deserves more attention.

**P01.2530. Long-Term Quality-Of-Care Summary Score Predicts the Occurrence of Microvascular and Macrovascular Complications in Type 2 Diabetic Patients**

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**Abstract:** Background: Diabetes requires long-term medical care and management of complications. However, besides the blood glucose level, no reliable method is currently available for linking the quality of care and the development of complications. We therefore developed a long-term quality-of-care score for predicting the occurrence of chronic kidney disease (CKD) and macrovascular diseases in type 2 diabetic patients. Methods: Using Taiwan's Longitudinal Cohort of Diabetes Patients database and the medical records in a medical center, we identified incident type 2 diabetic patients during 1999-2003 and followed them until 2011. A summary score (from 0 to 7) was calculated using process indicators (frequencies of HbA1c, lipid profile testing and urine, and retinal examinations), intermediate outcome indicators (low-density lipoprotein, blood pressure and HbA1c), and comorbidity of hypertension. Cox regression models were used to evaluate the association between the score and the incidence of complications. Results: Of the 2,184 patients enrolled, 598(27.4%) developed CKD after a mean follow-up of 9.3 years. Of the 1,694 patients enrolled, 696 (41.1%) developed macrovascular events after a mean follow-up of 8.6 years. Compared to the risk of developing a CKD event in patients with scores  $\leq 2$ , the risk was 72% lower in those with quality-of-care scores  $\geq 5$  (adjusted hazard ratio [AHR], 0.28; 95% confidence interval [CI], 0.20-0.40) and 36% lower in those with scores between 3 and 4 (AHR, 0.64; 95% CI, 0.53-0.76). Compared to the risk of developing a macrovascular event in patients with scores  $\leq 1$ , the risk was 66% lower in those with quality-of-care scores  $\geq 5$  (AHR, 0.34; 95% CI, 0.25-0.47) and 33% lower in those with scores between 2 and 4 (AHR, 0.67; 95% CI: 0.57-0.78). Conclusion: The score developed in this study had a good association with the risks of macrovascular complications and CKD thus can be applied to guiding the care for patients with type 2 diabetes.

## **P01.2540. Association of Lead Exposure on Cognitive Decline due to Mediation and Interaction with Uric Acid**

Vy Nguyen

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**Abstract:** **BACKGROUND:** Low-level cumulative lead exposure has been associated with cognitive decline in adults. Previous studies suggest that lead increases levels of the antioxidant uric acid and that uric acid may also predict changes in cognitive function. We explored whether uric acid mediated or interacted with lead in the association between lead exposure and cognitive decline. **METHODS:** From 1991 to 2002, a subset of the Normative Aging Study cohort of community-dwelling men was assessed for cumulative lead exposure in the tibia and patella bones. The Mini-Mental State Examination (MMSE) was administered as a test of global cognition starting in 1992. We conducted formal mediation analysis using the first bone lead measurement, uric acid concurrent with baseline MMSE, and the difference between the second and baseline MMSE scores, adjusted for age at baseline MMSE, education, serum creatinine, smoking status and pack-years, drinking status, and years between the two MMSE tests. **RESULTS:** 552 men [mean (standard deviation) age: 67.27 (6.52)] took two MMSE tests that were 3.92 (1.80) years apart and had valid bone lead measurements. The total change in MMSE score for an interquartile range (20 µg/g) increase in patella lead was -0.29 (95% confidence interval: -0.49, -0.08) (p=0.007), due mostly to the direct association with lead [-0.25 (-0.44, -0.06) (p=0.01)] when uric acid was set to the mean value; the component due to interaction only was -0.03 (-0.07, 0.004) (p=0.08), due to mediation and interaction was 0.02 (-0.001, 0.05) (p=0.06), and due to mediation only was -0.03 (-0.07, 0.01) (p=0.20). Results with tibia lead were less robust. **CONCLUSIONS:** Prior studies have indicated significant effects of patella lead on cognitive decline, but accounting for uric acid may be needed to understand the full association between lead and cognitive decline.

## **P01.2550. Associations between Parabens and Measures of Metabolic Syndrome in the General Canadian Population**

Joanne Kim

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**Abstract:** Background: Metabolic syndrome (MetS) is a cluster of risk factors which increases the risk of developing several chronic diseases. It is defined as having any three of the following risk factors: Abdominal obesity, elevated triglycerides, reduced high-density lipoprotein cholesterol, hypertension, and elevated fasting glucose. Parabens are preservative agents used ubiquitously in cosmetic and personal care products that may increase the risk of MetS due to their endocrine-disrupting properties. We examined if exposure to parabens was associated with MetS or component risk factors in the Canadian general population. Methods: Methyl, ethyl, propyl, and butyl paraben were measured in the urine of participants (n=2564, age 3-79) in Cycle 4 (2014 - 2015) of the Canadian Health Measures Survey (CHMS), a nationally representative biomonitoring survey in Canada. Linear and logistic regression were performed to investigate associations between each individual paraben and MetS, MetS components and related anthropometric measures, adjusted for age, sex, and household income. Results: Due to a high proportion of non-detectable measures for ethyl and butyl paraben (65% and 83%, respectively), only results for methyl and propyl paraben are reported here. Detection rates were high (92% and 79%) and geometric means were 17 ug/L and 2.5 ug/L for methyl and propyl paraben, respectively. Overall, parabens were associated with slightly decreased odds of MetS, and individual MetS components were generally inversely associated with paraben concentrations. However, among children and adolescents (age <18 years), parabens tended to be associated with higher BMI, though not statistically significant. Conclusions: In this cross-sectional analysis, there was little evidence that parabens are associated with MetS. Results considering paraben mixtures and interaction with triclosan will also be presented.

## **P01.2560. Children's Cognitive Function in Relation to Pre- and Postnatal Exposure to Chlordecone**

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**Abstract:** Background: Chlordecone (Kepome) is an organochlorine insecticide that was intensively used in banana fields in the French West Indies, therefore resulting in a widespread contamination of soils, water sources and foodstuff. Despite its proven neurotoxicity at acute exposures, data on its potential neurotoxicity at low exposures in human populations are scarce. Objective: To assess the associations between pre- and postnatal exposures to chlordecone and cognitive function in 7-years children from Guadeloupe. Methods: We examined 377 children from the TIMOUN mother-child cohort in Guadeloupe. Concentrations of chlordecone and other environmental contaminants were measured in maternal blood in the second trimester of pregnancy and in children's blood at age 7 years. Children underwent a battery of neuropsychological testing at 7 years, including the Wechsler Intelligence Scale for Children-IV (WISC-IV). We estimated covariate-adjusted associations between pre- and postnatal chlordecone exposure and child cognitive function using multivariable regression models. We also assessed potential effect modification by sex. Results: Prenatal chlordecone concentrations (geometric mean [GM]: 0.13 µg/L) were higher than at 7 years (GM: 0.06 µg/L). We found no pattern of associations between prenatal chlordecone concentrations and any of the WISC-4 composite or subtest scores. A twofold increase in chlordecone concentrations at 7 years were associated with decreased total IQ scores ( $\beta = -3.3$ ; 95% CI: -6.5, -0.1). This association was mainly driven by decreases in scores of perceptual reasoning ( $\beta = -5.8$ ; 95% CI: -9.9, -1.6). We found no evidence of effect modification by child sex. Conclusions: postnatal concurrent chlordecone exposures, but not prenatal exposures, were associated with lower cognitive function in children from Guadeloupe.

**P01.2570. Investigating the Association between Blood Lead Levels and Alzheimer's Disease Mortality Using NHANES 1999-2008**

Ellen Wells

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Abstract: Toxicological and epidemiological studies suggest that there is an association between lead (Pb) exposure and Alzheimer's disease (AD); however, few studies have explored Pb and AD mortality. The main objective of this study was to investigate the longitudinal association between blood Pb with subsequent AD mortality. Data from the 1999-2008 National Health and Nutrition Examination Survey (NHANES) and 1999-2014 linked National Death Index files were used for this longitudinal analysis. Analyses included 8084 adults aged  $\geq 60$  years with blood Pb data at the NHANES exam. Cox proportional hazards regression was used to estimate the hazard ratio of AD mortality by blood Pb tertile, adjusting for age, gender, income, race/ethnicity and smoking status. At the time of the NHANES survey, geometric mean blood Pb was 2.45 (95% confidence interval (CI): 2.39, 2.53). N=2227 participants died during follow-up; N=81 died from AD, which is a proportionate mortality of 3.89% (95% CI: 3.00, 5.00). Tertiles of blood Pb were  $< 1.50 \mu\text{g/dL}$ ;  $1.50$  to  $3.00 \mu\text{g/dL}$ ; and  $> 3.00 \mu\text{g/dL}$ . In adjusted models using the lowest blood Pb tertile as the referent, participants in the second and third blood Pb tertile had 1.61 (95% CI: 0.84, 3.11) and 1.74 (95% CI: 0.86, 3.52) times the risk of AD mortality, respectively. A limitation of this analysis is that the true burden of AD may not be well represented by mortality, as those with AD may die from other causes. However, this study has several strengths: it is longitudinal, uses a large sample, and is representative of the United States population. Although it was not statistically significant, results from this analysis suggest that there is an association of increased Pb with AD mortality. Further research in this area is recommended.

**P01.2580. Pesticide and Acute Asthma Attacks in California, Usa in 2005 to 2011: A Bidirectional Symmetric Case-Crossover Study**

Marcela Entwistle

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Abstract: In this study, a bidirectional symmetrical case-crossover method was applied to analyze the data obtained from Emergency Department Visits for asthma occurrence and publicly available EPA emissions data for methyl bromide and 1,3-dichloropropene in California, USA between 2005 and 2011. The effect modification of parameters through stratified analyses by sex (female, and male), race (Whites, Blacks, Hispanics, and Asian) and age (2-5, 6-18, 19-40, 41-64 and  $\geq 65$ ) is considered. In this work, 8566 individuals within the area under the study visited the emergency departments due to asthma attacks between 2005 and 2011. In addition, biweekly samplings of the concentration of the two pesticides, PM<sub>2.5</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub>, and O<sub>3</sub> and measures of relative humidity, temperature, and pressure were collected for 14 sites. Based on the results, methyl bromide is not positively associated with the occurrence of acute asthma attack in California, USA between 2005 and 2011. For 1,3-dichloropropene, a 0.01 ppb increase in its exposures during the event day was associated with a 4.9% increase in asthma ED visits. Stratifying for race and sex showed that the effect is nearly similar among different races and sex. However, it was found that those who were 65 years or older during the time period of the study were affected more by the exposure to methyl bromide, than the other age groups. It can be implied from the findings in this study that the pesticides, as toxic air pollutants, are related to asthma attacks; however, there is a lack of enough data to delve into this issue.

## **P01.2590. Case-Control Study on Lung Cancer and Residential Radon in South Korea**

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**Abstract:** Background/Purpose: Radon exposure is a major risk factor of lung cancer. The World Health Organization (WHO) defines radon as the major cause of lung cancer following smoking, with 3-14% of lung cancer occurring worldwide. The WHO recommends radon concentration lower than 100 Bq/m<sup>3</sup>. In recent years, most of the advances in personalized therapy in Non Small Cell Lung Cancer (NSCLC) patients also occurred in non-smokers. The purpose of this study was to assess the effect of residential radon exposure on the risk of lung cancer in non-smokers and female in Korea. Method: This study was designed a multicenter hospital-based case and community-based control study in Korea. The seasonal correction was applied to the measured values of the radon concentration in both the case and control groups. Total 1053 (481 cases and 572 controls) were included in the data. 1:1 propensity score matching was performed considering age, sex, smoking status, involuntary smoking status, number of ventilation, impervious ratio, and type of house. Odds ratio for the risk of lung cancer according to the status of smoking and sex were performed using logistic regression and nonlinear regression analysis. Result: After seasonal correction, mean and standard deviation of radon concentration was 69.67±49.99 Bq/m<sup>3</sup> in cases and 60.45±44.57 Bq/m<sup>3</sup> in controls. 200 cases and 200 controls were matched and 51% were females. When we analyzed radon concentration as continuous, we observed an adjusted odds ratio of 1.92(95% CI : 1.13-3.25) in never-smokers and 1.19(95% CI : 0.68-2.09) in smokers. The adjusted odds ratio was 1.93(95% CI : 1.09-3.43) in females and 1.19(95% CI : 0.72-7.98) in males. Conclusion: Residential radon increases lung cancer risk among non-smoker and female. Therefore, intensive investigation of the relationship between lung cancer risk and smoking status or sex should be conducted to elucidate this results.

## **P01.2600. Five-Year Lung Cancer Mortality Risk Analysis and Topography in Xuan Wei: A Spatio--Temporal Correlation Analysis**

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**Abstract:** Background: In Xuan Wei, the lung cancer mortality rate is five times higher than the country average, and continues to increase despite interventions to reduce indoor coal burning air pollution. This study aims to investigate the spatial and temporal trends of lung cancer in Xuan Wei from 2011 to 2015. Methods: The pooled data of lung cancer registries for all the towns in Xuan Wei was first collected. The spatial distributions of local relative production volumes and mine deposits were acquired. The spatial autocorrelation was explored by spatio--temporal GIS approach. Four sets of spatial analysis and spatial statistics were applied: 1) hotspot analysis and 3D-geographical visualization, 2) a spatially weighted sum, 3) spatial interrelation between coal mines and lung cancer mortality, and 4) a geographically weighted regression model. Results: Females exhibited higher lung cancer mortality than males, with an increasing trend observed for both sexes over time. The incidence rate in Laibin Town was the highest in Xuan Wei for each year. Higher mortality was found in counties with coal industries, especially for those over 30+ years old. The village-level mortality showed clustered trends. The hotspot analysis and 3D-geographical visualization demonstrated increasingly concentrated patterns around Laibin, Shuanglong, and Longchang. The mapped health risks showed the geographical pattern of potential lung cancer health risks from the coal mine, and spatio--temporal variations were found in the five-year period for both sexes. Conclusions: Lung cancer mortality has increased continuously since the third mortality survey in Xuan Wei. Geographically, the locations for different kinds of mines have interrelation with the lung cancer mortality in Xuan Wei. Specific exploration targeted at the local environmental health related to coal burning indoor air pollution is warranted.

## **P01.2610. Serum Concentrations of Polychlorinated Biphenyls and Risk of Uterine Leiomyomata**

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**Abstract:** Polychlorinated biphenyls (PCB) are persistent endocrine-disrupting chemicals with varying types and degrees of hormonal activity. Animal and human evidence suggests that sex steroid hormones are involved in the etiology of uterine leiomyomata (UL), common gynecologic neoplasms that can cause severe reproductive morbidity. Three retrospective studies have shown positive associations between PCB exposure and UL risk. We performed a case-cohort analysis examining the association between serum concentrations of PCBs and risk of UL in a cohort of premenopausal Black women from the Detroit, Michigan metropolitan area (2011-12). Eligible women were age 23-34 years and had no prior diagnosis of UL, autoimmune disease, or cancer. We collected demographic, behavioral, dietary, and medical data via self-administered questionnaires, telephone interviews, and in-person clinic visits. To identify UL, participants underwent transvaginal ultrasounds at baseline and at 20- and 40-month follow-ups. We collected non-fasting blood samples from a random subset of 454 participants at baseline, in which we measured 24 PCB congeners at the Centers for Disease Control and Prevention. We lipid-adjusted PCB concentrations and set values below the limit of detection (LOD) to LOD/sqrt(2). We examined total PCB concentration and groupings determined by hormonal activity. We used Cox proportional hazards regression models to estimate adjusted incidence rate ratios (IRR) and 95% confidence intervals (CI). Over 40 months of follow-up, we identified 132 incident UL cases. IRRs for total serum PCB concentrations of 30-39, 40-49, 50-59, and  $\geq 60$  vs.  $< 30$  ppb were 1.06 (95% CI: 0.67-1.66), 1.20 (95% CI: 0.69-2.08), 0.55 (95% CI: 0.21-1.41), and 0.87 (95% CI: 0.48-1.58), respectively. Estrogenic and anti-estrogenic PCB concentrations were not associated with UL risk. This study does not support the hypothesis that serum concentrations of PCBs measured in adulthood increase risk of UL among Black women.

## **P01.2624. Sun Avoidance and the Risk of Developing Breast Cancer: A Systematic Review and Meta-Analysis**

Troy Hillier

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**Abstract:** Background: A relationship has been hypothesized between moderate solar ultraviolet radiation (UVR) exposure and breast cancer. This hypothesis centers on the anti-proliferative and apoptotic properties of vitamin D, as well as increases in nocturnal melatonin concentrations which have been shown to slow cellular proliferation. To date, the literature on the effects of exposure to UVR and breast cancer risk have not been systematically reviewed and synthesized. Furthermore, the effects of sun avoidance (low amounts of time spent in the sun) in different exposure windows (adolescence vs. a period relevant to diagnosis) have not been compared. Methods: We conducted a systematic review and meta-analysis to investigate the association between sun avoidance (defined as less than an hour of sun per day) and the risk of developing breast cancer. Associations were estimated using random effects models. Heterogeneity was investigated through subgroup analyses and I<sup>2</sup> statistics. Results: Seven studies were included in this review with the majority (n=5) being conducted in Canada or the US. We observed an increased risk of breast cancer for individuals obtaining less than an hour of sun exposure per day during summer months compared to individuals that obtained greater than an hour (pooled relative risk (RR) = 1.15; 95% CI: 1.09-1.20). Heterogeneity among this body of literature was minimal (I<sup>2</sup> = 2.7%) Among studies that measured sun exposure over different life periods, sun avoidance during adolescence appeared to confer a qualitatively greater risk of breast cancer than that closer to diagnosis (pooled RR = 1.18; 95% CI: 1.05-1.30 vs. 1.05; 95% CI: 0.88-1.25). Conclusion: This is the first meta-analysis to estimate the risk of developing breast cancer associated with sun avoidance. The results of this study suggest that obtaining less than one hour of sun per day during summer months, especially in adolescence, could increase the risk of developing breast cancer.

## P01. Biomarkers of Exposure and Effects 1

### **P01.2630. The Association of Urine and Blood Arsenic Metabolites with Body Mass Index in the Bangladesh Fact Study**

Ahlam Abuawad

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Abstract: Ingested arsenic (As) undergoes methylation generating mono-methyl (MMA) and dimethyl (DMA) arsenicals; this facilitates urinary As (uAs) elimination and may reduce As toxicity. Higher MMA% in urine has been associated with higher risk for cardiovascular disease and cancer. Decreased MMA%, however, has been associated with increased risk of diabetes-related outcomes in populations from the US and Mexico. Our objective was to estimate the association between uAs and blood As (bAs) metabolites with BMI in adults from Bangladesh. Of the 610 participants in the Folic Acid and Creatine Trial (FACT) study, 528 participants (275 men and 253 women) had complete baseline data on BMI, bAs, uAs, plasma folate, cigarette use, and other factors of interest. Our preliminary results from the FACT dataset show the median inorganic arsenic (iAs) %, MMA% and DMA% species in urine were 13.2, 14.2, and 71.8 in men and 13.5, 10.7 and 75.7 in women. In blood, the medians for iAs%, MMA% and DMA% were 26.8, 45.1 and 28.1 for men and 26.8, 43.9 and 29.0 for women. Overall, the data revealed no association between As metabolites and BMI in men, but found an association in women. For uAs metabolites, the adjusted mean difference (95% confidence) in BMI for a 5% difference in MMA% was -0.74 (-1.24, -0.24) kg/m<sup>2</sup> and for a 5% difference in DMA% it was 0.45 (0.17, 0.74) kg/m<sup>2</sup>. The corresponding data for bAs metabolites were -0.22 (-0.65, 0.2) and 0.41 (0.04, 0.77), respectively. For both urine and blood metabolites, higher DMA% was associated with higher BMI levels in women. While the reason underlying the sex-specific findings is unclear, we speculate that it may be related to body fat, which is greater among women in Bangladesh. In future studies, we plan to pool multiple studies from Bangladesh to evaluate the consistency of these findings.

## **P01.2640. Cumulative Exposure to Organic Pollutants in French Children Assessed by Hair Analysis**

Alba Iglesias Gonzalez

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Abstract: In 2014, the total quantity of pesticide sales in the EU-28 amounted to close to 400'000 tons, with France as the second pesticide consumer with 75'000 tons used for agriculture (Eurostat 2017). Children represent one of the most vulnerable category of the population. Chronic exposure to pesticides has been proven in the literature to be highly related with developmental issues as well as with several diseases such as leukaemia. Although a few studies based on biomonitoring approaches were conducted in France to assess pesticide exposure in adults or pregnant women, studies conducted on children are still absent. Hair analysis has been proven to give more accurate and reliable information than urine and blood, becoming a promising matrix for biomonitoring of chronic exposure. Moreover, pesticide concentration in hair is correlated to the level of exposure. In the present study hair samples were collected from 142 French children from different areas: rural (n=36), urban (n=72), wine production (n=25) and a remote island (n=9). Hair samples were analysed with an analytical method (GC/MS-MS) allowing for the detection of 55 currently used and banned pesticides, 4 PCBs and 5 brominated flame retardants. All the samples tested positive for at least 9 and up to 37 compounds (average =21). Three organochlorine pesticides, 1 organophosphate metabolite and 1 pyrethroid metabolite were detected in all the samples. The highest concentration was observed for permethrine (>5000 pg/mg). The highest number of chemicals was observed in children living in urban areas (mean = 52) and the lowest in children from the remote island (mean = 28). Although these results cannot be considered representative of all French children, they demonstrate the diversity in the exposure between different areas. These results also highlighted the cumulative exposure to pollutants from different chemical families and for most of them provide the first values of concentration in children's hair.

## **P01.2650. Human Urinary Biomarkers of Exposure to the Plasticizer Deha**

Alexandra Nehring

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Abstract: Di (2-ethylhexyl) adipate (DEHA) is predominantly used as plasticizer in PVC consumer products, but can also be used in nitrocellulose base coatings and synthetic rubbers. Blends of DEHA with general-purpose phthalates improve low-temperature flexibility for consumer goods like garden hoses, gaskets and tubing. DEHA is also used to substitute Di(2-ethylhexyl)phthalate (DEHP) in some medical applications like e.g. nutrition transfer systems or tubing for hemodialysis. The use of DEHA for food contact materials like flexible PVC cling film is approved in several parts of the world (e.g. Europe, North America/Canada, Asia). All of these applications imply likely exposures of the general population. The former European Scientific Committee on Food evaluated the data available on DEHA in 1994 and derived a tolerable daily intake (TDI) of 0.3 mg/(kg bw\*d). We developed an online-SPE-LC-MS/MS method with isotope dilution to investigate the metabolism of DEHA and urinary excretion kinetics of its metabolites. 4 volunteers were dosed orally with 10 mg DEHA. Urine samples were consecutively collected for 48 hours after dosage. Following oral uptake, DEHA is quickly metabolized and excreted in urine as adipic acid, which, however, is not a specific biomarker. The side chain oxidized monoester metabolites of DEHA in urine, 2-ethyl-5-hydroxyhexyl adipate (5OH-MEHA), 2-ethyl-5-oxohexyl adipate (5oxo-MEHA), and 5-carboxy-2-ethylpentyl adipate (5cx-MEPA) were identified as specific and robust biomarkers. Urinary conversion factors were also established, whereby 5cx-MEPA, the major specific metabolite, represented approximately 0.2% of the oral dose in urine. We applied the specific DEHA biomarkers in a pilot biomonitoring study on German adults and pregnant Brazilian women and were able to detect all three biomarkers in the urine samples with the highest prevalence for 5cx-MEPA.

## **P01.2670. The Precision and Accuracy of Urinary Creatinine Analysis for Correction of Urine Dilution in Biological Monitoring Measurements**

Che-Jung Chang

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Abstract: Biomonitoring has been widely used to assess environmental exposure, and spot urine is commonly studied due to its easy sample collection. The variability of urine dilution has been crucial for assessing the exposure magnitude. Previous studies indicated that creatinine-adjusted concentrations are better correlated with the parent chemical concentrations in blood, plasma or serum than unadjusted concentrations. More recent studies have documented problems with creatinine-adjustment in pregnant women and diverse populations because creatinine varies with age, gender, race, body size, and diet. In addition to the inter- and intra-person variability in creatinine, we found significant variability in the testing methods and the testing laboratories. Two immunoassays gave decidedly different concentrations on the same samples in two different laboratories and even had a greater than 35% bias on NIST Standard Reference Materials. In an attempt to standardize the creatinine measurements, both laboratories adopted the same immunoassay. The inter-laboratory relative percent differences (RPD) ranged from 0.3-13.4% with 5.2% median, and the values determined in each laboratory were highly correlated (Pearson correlation coefficient:  $r=0.98$ ). Although the results were correlated and relatively precise, 15% biases were found between laboratories with values determined by laboratory B being uniformly higher. The directional significant differences were confirmed by paired t-test ( $p$ -value $<0.001$ ). Thus, a systemic error can occur among different laboratories which might alter the point estimates of central tendency and percentile concentrations. The results show that in addition to the inherent limitations of biological variation in using creatinine-adjustment in biomonitoring, laboratory error from non-standardized measurements can further introduce variation. Taken together, we suggest that the standardized creatinine measurement or cross-laboratories validation is needed.

## **P01.2680. Serum Metabolomics of Children Exposed to Carcinogenic Pollutants from Petrochemical Industries**

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**Abstract:** Background: Petrochemical industries emit multiple carcinogenic pollutants that could induce common complex diseases, warranting a systemic evaluation of exposures and health impacts on nearby communities. Methods: We applied serum metabolomics approach to identify potential multiple pollutants exposure-induced metabolic changes that could contribute to disease onset. 106 children (aged 9-15) who have lived for more than 5 years near a petrochemical complex in Taiwan were selected. Subjects were defined as high or low exposure group according to distance from their home locations to two main emission points of the complex, and urine concentrations of exposure biomarkers. Individual exposure levels of multiple carcinogenic pollutants including urine heavy metals and 1-hydroxypyrene (1-OHP) were analysed using inductively coupled plasma mass spectrometry and high performance liquid chromatography, respectively. Serum targeted metabolites, lipidomic profiles, and 30 acylcarnitines were analysed using ultra performance liquid chromatography coupled with quadrupole time-of-flight tandem mass spectrometry. Results: Significantly increased urine concentrations of 1-OHP, vanadium, arsenic, strontium, cadmium, and thallium were found in high exposure group compared to low exposure group. Targeted metabolomics showed 6 upregulated metabolites and 3 downregulated metabolites in high exposure group compared to low exposure group. Lipid profiles showed clear separation between the two exposure groups, and identified 45 potential exposure-related lipids. 8 acylcarnitines were significantly decreased in high exposure group compared to low exposure group, and 2 were significantly increased. Conclusions: Our results demonstrate how a mixture of carcinogenic pollutants emitted from petrochemical industrial sources increased internal exposures in nearby populations in a distance-to-source-related manner, and induce metabolomic changes that could lead to adverse health effects in children.

## **P01.2690. Pesticide Urinary Metabolite Levels in Asthmatic Children Residing in Subsidized Housing**

Derek Werthmann

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**Abstract:** We examined urinary pesticide (UP) metabolite levels in asthmatic children residing in subsidized housing in New Orleans, Louisiana and compared these levels between children residing in green and non-green housing. Morning void samples were collected from 68 children (aged 7-12 years) at three time points between 2014 and 2016. Ninety-seven percent of children provided three urine samples. Urine samples were analyzed for seven pesticide metabolites (3 organophosphates: TCPY, IMPY, PNP; 3 pyrethroids: 4-F-3-PBA, 3-PBA, trans-DCCA; and 1 herbicide: 2,4-D). Metabolites were creatinine-adjusted and natural log transformed. Children were classified as residing in green housing if the home was constructed with low VOC materials and utilized integrated pest management. Differences in metabolite levels were analyzed using generalized estimating equations. Four metabolites (2,4-D, TCPY, 3-PBA, PNP) were detected in >90% of samples. IMPY was detected in 52% of samples, and 4-F-3-PBA and trans-DCCA were not frequently detected (<9%, <13%, respectively). There were no statistically significant differences in UP level at any time point. There were lower levels of 4-F-3-PBA ( $\beta=-1.23$ ,  $p=0.11$ ), TCPY ( $\beta=-0.05$ ,  $p=0.63$ ), and PNP ( $\beta=-0.01$ ,  $p=0.93$ ) for children living in green housing. 2,4-D ( $\beta=0.09$ ,  $p=0.43$ ), 3-PBA ( $\beta=0.08$ ,  $p=0.63$ ), IMPY ( $\beta=0.02$ ,  $p=0.90$ ), and trans-DCCA ( $\beta=0.37$ ,  $p=0.07$ ) levels were higher for those in green housing. None of the differences in housing type reached statistical significance. In models examining the interaction between housing type and time, there were no statistically significant differences between green and non-green housing at any time point. These results suggest that asthmatic children residing in subsidized housing in New Orleans are chronically exposed to low levels of pesticides resulting in limited variability of UP metabolite. We found no significant differences in UP levels between children residing in green housing compared to non-green housing.

## **P01.2700. The Association between Olfactory and Cognitive Function Tests with Aluminum Biomarkers in an Occupationally Exposed Population from Zunyi, China**

Hasan Zainab

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**Abstract:** High aluminum (Al) exposure has been associated with neurological and olfactory disorders; however, the degree to which Al damages the brain remains unknown. Therefore, the aim of this cross-sectional study of factory workers from Zunyi, China was to determine the relationship between cognitive and olfactory function with three Al biomarkers: bone (BnAl) (n=43), blood (WbAl) (n=60) and fingernail (FnAl) (n=61). Olfactory function was assessed with the University of Pennsylvania Smell Identification Test and cognitive function was assessed with the WHO/UCLA Auditory Verbal Learning Test (AVLT). Bone measurements were taken noninvasively with a compact in-vivo neutron activation analysis system and both WbAl and FnAl samples were analyzed using inductively coupled plasma mass spectrometry. Other variables were self-reported via questionnaire. Linear regression models adjusted for age, education, factory, current alcohol consumption and current smoking status. Median Al values were: 235 µg/L (interquartile range (IQR)=72) WbAl; 35 µg/g (IQR=50) FnAl and 15 µg/g (IQR=28) BnAl. Unadjusted regressions indicated a significant decrease in olfactory function related to an increase in Al for both FnAl ( $\beta=-0.045$ , 95% confidence interval (CI)=-0.086, -0.004) and WbAl ( $\beta=-0.011$ , 95% CI=-0.018, -0.004). Adjusted regression models showed a significant association between increasing WbAl and increased AVLT intrusions (worse performance) for trial 3 ( $\beta=-1.002$ ,  $p=0.004$ ) and 7 ( $\beta=-2.473$ ,  $p=0.002$ ). Our study found some, but not all, measures of short-term Al exposure were significantly associated with olfactory and cognitive tests. None of the test outcomes were significantly associated with BnAl, a novel measure of cumulative Al exposure. Larger studies are needed to definitively confirm the lack of association between BnAl with cognitive and olfactory function.

**P01.2710. Association of Urinary Phthalate Metabolites and Phenolics with Metabolic Syndrome Related Biomarkers among Reproductive Age Women of Korea**

Inae Lee

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**Abstract:** Endocrine disrupting chemicals (EDCs) such as phthalates and phenolics have been associated with metabolic syndrome (MetS) among humans. However, limited information exist on relationship of EDCs with adipokines and lipid profiles in humans. In the present study, reproductive age women (n=516, aged 20s to 40s) were recruited from major cities throughout the Korea between 2015 and 2016, and measured for phthalate metabolites and environmental phenols in urine samples. MetS related biomarkers such as adiponectin, leptin, glucose, insulin, high density lipoprotein (HDL)-cholesterol, triglycerides (TG), and total cholesterol (TC) were also analyzed in serum. Multivariable linear regression was used to assess the association between urinary chemical profile and the MetS related biomarkers. Urinary di-(2-ethylhexyl) phthalate metabolite ( $\Sigma$ DEHP), mono-methyl phthalate (MMP), mono-benzyl phthalate (MBzP), and bisphenols S (BPS) levels were positively associated with glucose after adjusting for age, body mass index (BMI), alcohol consumption status, smoking, and urinary creatinine. Urinary DEHP and MBzP levels were positively associated with adiponectin, but urinary MMP and DEHP metabolite levels were negatively associated with TC after adjusting for the covariates. MMP, ethyl paraben (EtP), propyl paraben (PrP), and benzophenone-1 (BP-1) were negatively associated with BMI after adjusting for age, alcohol consumption status, smoking, and urinary creatinine. These observations showed that exposure to phthalates and phenolics may be associated with MetS among reproductive age women. Further studies on possible interaction among the chemicals and replication in other populations are warranted.

## **P01.2720. Cadmium and Kidney Function in the U.S. Population: Impact of Sex, Diabetes and Hypertension**

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**Abstract:** Exposure to cadmium has been associated with nephropathy and the development of diabetes and hypertension, but may be an underexplored risk factor for decreased kidney function among people with preexisting diabetes and/or hypertension. Our objective was to evaluate sex, diabetes, and hypertension status as effect modifiers of the association between cadmium exposure and kidney function. We used data from adults in the National Health and Nutrition Examination Survey (NHANES) 2007-2012 cycles. Multivariable adjusted linear and logistic regression models were used to conduct a cross-sectional analysis of the association between blood levels of cadmium and estimated glomerular filtration rate (eGFR), urine albumin to creatinine ratio (UACR), low eGFR (eGFR <60 mL/minute/1.73m<sup>2</sup>), and albuminuria (UACR > 30 mg/g). Interaction terms were evaluated for cadmium level and sex, diabetes, and hypertension. Final models were stratified by sex and existing diabetes and hypertension status. Cadmium levels were negatively associated with eGFR, with significant interactions for cadmium and sex, cadmium and hypertension, and cadmium, sex, and hypertension. The association between high cadmium exposure and low eGFR was strongest among females with hypertension and diabetes ( $\beta = -4.3$  (95% CI -7.6 to -0.91)) or hypertension alone ( $\beta = -2.4$  (95% CI -4.5 to -0.42)). Among males with diabetes, exposure was associated with lower eGFR ( $\beta = -5.9$  (95% CI -10.5 to -1.3)). Among females, exposure was associated with a 70% increase in the odds of low eGFR (OR 1.7 (95% CI 1.4 to 1.9)). The odds of low eGFR were increased among those with hypertension (OR 1.7 (95% CI 1.4 to 2.0)) compared to those without (OR 1.2 (95% CI 0.93 to 1.5)). Our results provide evidence that the magnitude of these associations differs by sex and may vary by preexisting diabetes and hypertension status. Future investigations should be sex-specific and further environmental contamination from cadmium must be prevented.

## **P01.2740. Human Urinary Biomarkers of Exposure to the UV Filter Avobenzone**

Kathrin Papadopoulos

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Abstract: Avobenzone (butyl methoxydibenzoylmethane) is a UV-A filter widely used in personal care products (sunscreens and other cosmetics), with maximum permitted concentrations of 3% in the U.S. and 5% in the European Union. Due to its widespread use in consumer products, exposure of the general population is probable. Therefore, avobenzone was selected as a substance of concern within the scope of a large scale cooperation project between the German Ministry for the Environment (BMU), German Chemical Industry Association (VCI) and the German Environment Agency (UBA). This project has the aim to establish new human biomonitoring (HBM) methods for 50 emerging chemicals. For the identification of avobenzone metabolites as suitable biomarkers of exposure, we orally dosed five volunteers with neat avobenzone (5 mg). Consecutive and complete urine samples were collected over a period of 48 h post dose. The urine samples were analyzed with a data-mining software-assisted suspect screening approach, using liquid chromatography-high resolution mass spectrometry (LC-HRMS and -MS/MS). A variety of specific avobenzone metabolites (including hydrogenated, hydroxy, and carboxylic acid metabolites) was tentatively identified and semi-quantitative elimination kinetics for each metabolite were obtained. We selected the four most promising urinary metabolites as exposure biomarker candidates for HBM method development. We currently investigate human metabolism quantitatively, derive urinary metabolite excretion factors, and analyze samples from sunscreen users and the general population (LC-QqQ-MS/MS using analytical standards and stable isotope labeled internal standards) to assess the suitability of these metabolites as avobenzone exposure biomarkers. It is then planned to use these biomarkers in large scale population studies such as the German environmental survey (GerES) or the German Environmental Specimen Bank (ESB).

**P01.2750. Investigating the Association of a Biomarker of Triphenyl Phosphate Exposure with Metabolic Health in the U.S. Population**

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**Abstract:** Background: Triphenyl phosphate (TPHP) is a flame retardant and plasticizer found in commercial and consumer products. The primary metabolite, diphenyl phosphate (DPHP), occurs widely in urine samples. There is a lack of epidemiological data to support the toxicological evidence regarding TPHP's role in disrupting metabolism. Objective: We evaluated the association of urinary DPHP with fasting plasma glucose, hemoglobin A1c, homeostatic model assessment of insulin resistance, 2-hour oral glucose, and waist circumference using data from NHANES 2013-2014. Methods: Data were available for 1,201 adults aged 20 years and up with no prior diabetes diagnosis. We used two methods to account for urine dilution of DPHP: 1) urinary excretion rate (UER) of DPHP estimated by multiplying urine concentration by urine flow rate; 2) a recently proposed method of covariate-adjusted creatinine standardization with less potential bias than traditional creatinine correction. We assessed the relationship between quartiles of urinary DPHP and each outcome using multiple linear regression models, adjusting for confounders. Results: Preliminary analyses of males yielded no clear trends across quartiles for the outcomes, but results were elevated in some quartiles. Males in Q4 of creatinine standardized DPHP had higher waist circumference than males in Q1 ( $\beta= 7.70$ , 95% CI: 3.2, 12.2). Males in Q2 of DPHP had 9.4% higher fasting plasma glucose compared to males in Q1 ( $\beta= 0.094$ , 95% CI: 0.019, 0.17). Use of UER DPHP yielded similar results with waist circumference, although only marginally significant (Q4:  $\beta= 5.22$ , 95% CI: -0.37, 10.8). As toxicological data suggest the potential for effect measure modification by menopause status in women and diet, we are conducting additional sub-group analyses. Conclusion: In men, urinary DPHP was positively associated with certain measures of metabolic disruption, but with no clear trends. Analysis of potentially more susceptible sub-groups is underway.

**P01.2760. Correlation over Time of Toenail Metals among Participants in the VA Normative Aging Study from 1992 to 2014**

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**Abstract:** Background Scientists use biomarkers to evaluate metal exposures. One biomarker, toenails, is easily obtained and minimally invasive, but less commonly used as a biomarker of exposure. Their utility will depend on understanding characteristics of their variation in a population over time. The objective of our study is to describe the correlation of toenail metal levels many years apart among participants in the VA Normative Aging Study (NAS). Methods Toenail clippings from 825 participants of the NAS from year 1992 to 2014 were analyzed for lead (Pb), Arsenic (As), Cadmium (Cd), Manganese (Mn), and Mercury (Hg). We utilized linear mixed models to assess correlation between toenail metal concentrations in multiple toenail samples from the same subject collected years apart and identified the optimal covariance pattern by likelihood ratio tests and Akaike's information criterion (AIC). Correlations among different metals were described using Spearman correlations. Results The average number of times toenail samples were collected from each subject ranged from 1.63 (Hg) to 2.04 (As). The average number of years between toenails collected per subject ranged from 4.73 (SD=2.44) (Mn) to 5.35 (SD=2.69) (Hg). Metal concentrations had slightly different correlation patterns over time, although for all metals correlations decreased with increasing time between samples. Estimated correlations over a 3-year span were highest for toenail Pb (0.68) and Hg (0.67), while As, Cd, and Mn had lower correlations of 0.49, 0.44, and 0.47, respectively. Even across a six-year span, the lowest correlation was 0.35 (Cd). Conclusion Our results suggest that Pb, As, Cd, Mn, and Hg levels from toenail clippings can reasonably reflect exposures over several years in elderly men in the NAS. Even across six years, toenail metal levels were generally well correlated among NAS participants. As such, they may be useful as biomarkers of exposure in epidemiological studies of similar populations.

## **P01.2810. Household Exposures, Glutathione S-Transferase Genes and Asthma Risk in Middle-Age**

Xin Dai

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**Abstract:** Background/Aim Household exposures may induce lung oxidative stress and increase asthma risk. This risk may be modified by variants of Glutathione S-Transferase (GST) genes. We aimed to determine whether household exposures influenced asthma risk in middle-aged adults and whether this was modified by GST genes. Methods We used data from the Tasmanian Longitudinal Health Study, which followed the whole population of Tasmanian 7 year olds from 1968 until their 6th decade (aged 53 years). Information from 3314 participants about consistent household exposures (heating, cooking, mould, carpets, pets, smoking) and asthma were obtained by questionnaires at ages 45 and 53. GST genes (GSTM1, GSTT1 and GSTP1) were typed on blood samples collected at age 45. Multivariable logistic regression estimated odds ratios (OR) and 95% confidence intervals (CI) for associations between consistent household exposures (over 8 years) and current asthma at 53 years (asthma symptoms or medication in last 12 months) (N=3314) and interactions by GST genotype (N=928). Results Having carpets in bedrooms consistently (over 8 years) was associated with a reduced risk of current asthma at 53 years (OR 0.55, 95%CI 0.34-0.89), compared with no bedroom carpets, after adjusting for baseline asthma. Persistent active smoking was associated with an increased risk of current asthma at age 53 (OR 1.47, 95%CI 1.06, 2.00) compared with never smokers, but there was no association with environmental tobacco smoke, or other household exposures. GST genes were not associated with asthma and did not modify relationships between household exposures and asthma. Conclusions We found evidence that bedroom carpets reduced asthma risk in middle age, whereas active but not passive smoking at home increased asthma risk. GST genes did not modify relationships between household exposures and asthma. The unexpected finding for carpets may be reverse causation, requiring further investigation.

## **P01.2820. A Profile of Exhaled Volatile Organic Compounds Measured Using PTR-TOF-MS for Diagnosis of Chronic Obstructive Pulmonary Disease**

Xu Yifan

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**Abstract:** Background: Chronic obstructive pulmonary disease (COPD) is one of the leading causes of global death. The diagnosis of COPD clinically relying on pulmonary function tests is invasive for the elders. Method: To develop a non-invasive and efficient diagnosis method for COPD, a panel of 102 subjects, including 44 stable COPD patients and 58 healthy control, were recruited in Beijing, China. The exhaled gas of each subject was collected with Tedlar bags and then analyzed with proton-transfer-reaction time-of-flight mass spectrometry (PTR-TOF-MS). Binary logistic regression model was used to evaluate the associations between exhaled VOCs level and the classification of subjects, modified by smoking status. Results: Among 260 VOCs identified as endogenous VOCs, 16 key VOCs had discriminative values. The performance of classification of COPD patients using the 16 VOCs delineates an area under the curve (AUC) of 0.93 in the Receiver Operating Characteristic (ROC) curve. 10-folds cross validation demonstrated that the discriminative model has a predictive accuracy of 0.909. Among the 16 VOCs, the level of [m/z=34.99, 46.03, 47.05, 69.07, 73.03, 101.10, 169.16, 243.08] were not significantly higher or lower in the subjects with asthma, diabetes mellitus, hyperlipemia, or smoke history, which indicates that the method is specific for COPD diagnosis. Tentative conclusion: In conclusion, several specific exhaled VOCs were screened out for the non-invasive diagnosis of COPD using PTR-TOF-MS, which is promising for clinical uses. The screened VOCs should be further characterized and their metabolic pathways require further research.

## **P01.2830. MnSOD Polymorphism May Modify the Association between Exposure to Dioxin and Diabetes**

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**Abstract:** Background/Aim: Manganese superoxide dismutase (MnSOD) is an antioxidant, and might play an important role to diabetes (DM) pathogenesis. Dioxin may also cause effects with aryl hydrocarbon receptor (AhR) and induce DM. The interaction between exposure to dioxin and MnSOD gene polymorphism has not been investigated yet. Our study was to assess the joint effects of MnSOD polymorphism and exposure to dioxin on the risk of DM. Methods: A total of 282 individuals were selected from Central Taiwan to conduct a cross-sectional study. We used real-time polymerase chain reaction (RT-PCR) to analyze the four single-nucleotide polymorphisms (SNPs) of MnSOD (rs5746136, rs2855116, rs4880, rs2758346) and performed Haploview v4.1 software to test the MnSOD gene for Hardy-Weinberg equilibrium. The dioxin data were measured by chromatography/mass spectrometry (HRGC/HRMS) and divided dioxins levels into four groups: reference group (<25th), low exposure group (25th to <50th), middle exposure group (50th to <75th) and high exposure group ( $\geq$ 75th). We performed logistic regression models to assess the risk for diabetes and applied Rothman index (s) to estimate interaction in additive scale. Result: After adjusting for confounding, we found that the risk of DM was associated with the low and middle combined exposure group of OCDF(aOR=3.25; 95% CI=1.07-9.81), PCDDs(aOR=5.12; 95% CI=1.46-18.62), 1,2,3,7,8-PeCDD(aOR=4.03; 95% CI=1.18-13.78), 1,2,3,4,7,8-HxCDD(aOR=3.79; 95% CI=3.79-13.37) and OCDD(aOR=4.00; 95% CI=1.42-11.26) as compared with reference group. Additive interactions between SNP (rs2758346) and the specific dioxin (PCDDs: S=1.592; 1,2,3,7,8-PeCDD: S=2.138; 1,2,3,6,7,8-HxCDD: S=1.642) on the risk of diabetes was found. Conclusions: Our study suggests that MnSOD (rs2758346) may modify the association between exposure to specific dioxin (PCDDs, 1,2,3,7,8-PeCDD and 1,2,3,6,7,8-HxCDD) and DM.

**P01.2840. Effects of 3-PBA on Complete Blood Count (CBC) and Liver Enzyme in Human: The Second Korean National Environmental Health Survey (KONEHS)**

Yuming Lee

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Abstract: Pyrethroid were synthetic analogues insecticides as pyrethrins. They are known to be effective in insects because they are degraded by rapid metabolism in mammals. However, health effects that occur are not clearly known in human. In this study, we evaluated the effect of exposure of low concentrations of insecticide, rather than high concentration exposure, on human health. This study was performed on 5474 adults aged 19 years and older based on the Second Korean National Environmental Health Survey(KoNEHS 2012-2014). We used regression analysis to examine the effects of 3-PBA (phenoxybenzoic acid, as metabolite of pyrethroid) levels in urine on the complete blood count (CBC; white blood cell, red blood cell, hemoglobin, and platelet) and liver enzymes (AST, ALT,  $\Gamma$ -GPT). As clinical laboratory values are different according to sex, they are stratified. Thus, urinary 3-PBA/Cr, liver enzymes were transformed logarithmically due to their skewed distribution. Geometric mean concentrations of urinary 3-PBA were 1.94 $\mu$ g/L/Cr in total, 1.59 $\mu$ g/L/Cr in men, and 2.41 $\mu$ g/L/Cr in female, respectively. Association between log-transformed urinary 3-PBA and liver enzymes were not statistically significant. However, association between log-transformed urinary 3-PBA and RBC and hemoglobin were statistically significant, respectively (adjusted coefficient=-0.018 (0.009),  $p=0.0425$ ; -0.043(0.025)  $p=0.0791$ ). After stratification, there was a negative association between log-transformed urinary 3-PBA and RBC and hemoglobin only for male group (adjusted coefficient=-0.024 (0.035),  $p=0.0385$ ; -0.097(0.011)  $p=0.0064$ ). Low concentrations of pyrethroid exposure showed a statistically significant decrease in RBC and hemoglobin in humans. Liver enzymes, however, tended to increase, although not statistically significant. The results of this study need to educate the public about not being exposed to pesticides, and in order to do so, we must try to find these exposure factors in our living environment.

**P01.2842. Persistent Organochlorine Pollutants: Genetic Variations Associated with DDE and PCB153 Blood Levels among Women in France**

Takiy Eddine Berrandou

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**Abstract:** Persistent Organochlorine Pollutants including Dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) are ubiquitous in the environment. Many studies have attempted to link DDT or PCB levels in human tissues to the risk of breast and other cancers. However, little attention has been paid to the genetic determinants of DDT and/or PCBs levels. Our aim was to identify genetic variants modifying blood levels of DDE (the major breakdown product of DDT) and PCB153 measured in a sample of women in France. Blood levels of circulating DDE and PCB153 were measured in 1236 healthy women selected as control subjects in an epidemiological study on breast cancer. We genotyped 474 Single Nucleotide Polymorphisms (SNP) in 54 CYP and GST genes involved in the metabolism of DDT and PCBs. Blood concentrations of DDE and PCB153 were explored in relation to each SNP and to the genetic variation in the genes using the Adaptive Rank Truncated Product method. This approach allows investigating the role of a gene seen as a set of SNPs or of a set of genes in DDE and PCB153 levels, and to gain statistical power as compared to a SNP by SNP approach. P-values were adjusted for multiple testing by False Discovery Rate (FDR) method. Blood levels of DDE and PCB153 were significantly associated with several SNPs located in CYP genes. The top-SNPs were rs8192719 (FDR=3x10<sup>-26</sup>) for DDE and rs7255904 (FDR=0.01) for PCB153, both located in CYP2B6. At the gene level, CYP2B6 was associated with levels of DDE (FDR=2x10<sup>-4</sup>) and PCB153 (FDR=0.01). Genetic variation in the whole gene-set including CYPs and GSTs was significantly associated with blood levels of DDE (p=2x10<sup>-4</sup>) and PCB153 (p=2x10<sup>-4</sup>). These findings show that polymorphisms in genes involved in the metabolism are important determinants of organochlorine compound levels measured in humans, and should be taken into account as possible modifiers of the association between PCB and DDT levels and disease risk in epidemiological studies.

## P01. Risk Assessment and Policy 1

### **P01.2850. The Consumption of Fluoridated Water during the Development of the Rat Modifies the Emotional State**

Jairo Alvarez

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**Abstract:** Background/Aim: Access to safe drinking water is essential to health, a basic human right and a component of effective policy for health protection. Fluoride (F) is present ubiquitously in the environment, including surface and groundwater. This compound has therapeutic properties to prevent tooth decay at low concentrations, but some research has demonstrated its toxic effects at several concentrations. Clinical and experimental studies have reported that F induces changes in cerebral morphology and biochemistry that affect emotional processes, such as anxiety and depression. The World Health Organization recommends a F concentration of 1.5 mg/L; in Mexico, the legislation establishes 0.7 mg/L as the maximum limit for drinking water. The aim of this study was to evaluate the effects of F on behavior through the forced swim test (FST) in rats exposed to F in drinking water. Method: Male Wistar rats were exposed orally to F in drinking water at concentrations of 0.7, 1.5, 5 and 10 mg/L since gestation until 90 days after parturition. Two control (C1 and C2) groups were performed, C1 with distilled water and C2 with distilled water and fluoxetine at 1 mg/kg during the last 10 days. After exposure, FST and open field test were carried out to determine the depressive-like behavior and to exclude locomotor impairment, respectively. Results: F exposure at these doses changes the variables evaluated in FST, e.g. immobility, but do not alter locomotive capacities. Fluoxetine administration in C2 group decreased immobility in comparison to C1 group and without changes on locomotor activities. Conclusions: Results shows that exposure to F during development can yield to a depressive-like behavior in rats, suggesting that high intake of F must be prevented to avoid harmful effects at adulthood.

**P01.2860. Children's Lead Exposure from Consumption of Backyard Chicken Eggs: Health Risks from a Non-Traditional Source**

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Abstract: Backyard chicken (BYC) ownership is increasingly popular in the United States, especially in urban areas, largely motivated by a desire for fresh, non-commercial eggs and engaging children in agriculture. The role of BYC egg consumption as a pathway for exposure to environmental contaminants, particularly child exposure to lead, remains largely unstudied. A limited number of studies in the US and Europe document lead in BYC eggs and report levels that exceed those in commercial eggs, but children's health risk from BYC eggs has not been determined. To characterize lead exposure and health risk among children consuming BYC eggs, we conducted a cross-sectional study of BYC owners in Greater Boston, MA, US (n=51). From these households, we collected 201 egg samples and analyzed them for lead concentration using inductively coupled plasma mass spectrometry (ICP-MS). Lead was detected in 96% of the egg samples. Concentrations ranged from below the detection limit ( $2.0 \times 10^{-6}$ ) to 1.798  $\mu\text{g/g}$  with median and mean concentrations of 0.022 and 0.098 (SD: 0.204)  $\mu\text{g/g}$ , respectively. We incorporated egg lead concentration data along with egg consumption rates for children living in the households into the USEPA's Integrated Exposure Uptake Biokinetic Model to predict child blood lead levels (BLLs). We then compared BLLs to the California EPA (CalEPA) child-specific reference dose (chRD) of 1.0  $\mu\text{gPb/dL}$  blood. For children less than 7 years old who frequently eat eggs (about 4 medium eggs/week) with a 95th percentile lead concentration of 0.324  $\mu\text{g Pb/g}$  egg, the incremental change in blood lead was predicted to be 0.9 to 1.5  $\mu\text{g/dL}$ . The upper end of this range exceeds the CalEPA chRD, which is intended to protect against increased risk of neurological deficit due to lead exposure. Our results reflect the highest detected lead concentrations in BYC eggs reported to date. Frequently consuming BYC eggs with high egg lead concentrations may pose health risks to children.

## **P01.2870. Clinical Indices and Fatal Cases in Hospitalized H7N9 Patients**

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**Abstract:** Background/Aim: H7N9 has lasted for over five years in China, resulted in more than 1500 cases with a fatality rate of 40.5%. This research aimed to identify the key clinical indices and estimated the fatality risk of infected H7N9 patients admitted to hospital. Methods: We performed a retrospective epidemiological investigation to collect laboratory - confirmed H7N9 viral infected cases from 2013 to 2015 in Guangdong province, China. Data with clinical outcomes and biochemical indices were collected after patients and hospitals permission. Multivariable logistic regression model and classification tree model were used to evaluate the risk factors of H7N9 death. The receiver operating characteristic curve (ROC) and survival analysis were used to compare survival and death distribution and difference. Results: The results indicated that body temperature (BT) average (Odds Ratio (OR) = 3.612, 95% Confidence Interval (CI) = 1.914-6.815), white blood cell (WBC) average (OR = 1.212, 95%CI = 1.092-1.346), WBC maximum (OR = 1.095, 95%CI = 1.043-1.149), hemoglobin minimum (OR = 0.981, 95%CI = 0.965-0.996), platelet average (OR = 0.990, 95%CI = 0.986-0.995), lymphocyte average (OR = 0.230, 95%CI = 0.064-0.831) were identified as the independent risk factor for mortality with H7N9 after adjusting the confounders (underlying disease, age and sex). Moreover, WBC average, WBC maximum and BT average were the most reliable indices for predicting mortality with high sensitivity and specificity. There was an 80.0% chance for a death of H7N9 if BT was over 38.1°C, 67.4% chance if WBC average over 9.5 ( $10^9/L$ ) and 86.4% chance if WBC maximum over 23.1 ( $10^9/L$ ). Conclusions: We screened a series of clinical variables through rigorous statistical methods to provide a reference for the treatment and survival prediction of H7N9 cases.

**P01.2880. The Role of the Gut Microbiome on Mercury Toxicology: Protein-Rich Diet Alters Gut Microbiota Composition and Increases Methylmercury Demethylation**

Galen Guo

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Abstract: Methylmercury (MeHg) exposure is a global health concern particularly among coastal populations that rely on fish and marine mammals for sustenance. It has been shown that diet can modulate the MeHg kinetics and body burden. The gut microbiome has been identified as a major factor affecting contaminant metabolism, but little is known about the role of gut microbiota on mercury transformations. The objective of this study was to examine the effects of diet on the human gut microbiome and its subsequent effect on MeHg metabolism. Using a series of batch experiments, we evaluated the effects of a changing nutritional component of the diet (by altering relative abundances of carbohydrate or protein) in the gut microbial community structure of two individuals. We measured mercury methylation and demethylation rates using a stable isotope tracer and conducted high throughput sequencing of the 16S rRNA metagenomic analysis to determine the microbial community structure. We observed >90% decrease in initial MeHg concentration in protein-rich diet mixed with the fecal slurry of individual A. Moreover, two microbial taxa were significantly increased from non-detectable to a total of 20% in relative proportion. Individual B gut microbiota did not exhibit similar results. A mixture of different ratios of gut microbiota of individual A and B showed similar demethylation rate as in individual A indicating that the phenotype can be conserved. Our results show that the gut microbiome of some individuals contains microbiota that can be promoted by a protein-rich diet and can increase demethylation of MeHg. The mechanism of the demethylation of MeHg needs to be characterized.

**P01.2890. Association between Private Drinking Water Wells and the Incidence of Campylobacteriosis in Maryland: An Ecological Analysis Using Data from the Foodborne Diseases Active Surveillance Network (FoodNet)**

Rianna Murray

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**Abstract:** Background: Campylobacter is a leading cause of foodborne illness in the United States. Campylobacter infections have most often been associated with food-related risk factors, but recent studies have identified environmental risk factors for campylobacteriosis, including contact with livestock and consumption of contaminated water. No previous studies have evaluated the association between private wells and campylobacteriosis rates in Maryland. Given that the Safe Drinking Water Act does not regulate the water quality of private wells, these could be an important non-foodborne transmission pathway for Campylobacter. Objective: We examined the zip code-level association between the number of households in Maryland that rely on drinking water from private wells and the incidence of campylobacteriosis. Methods: Data on culture-confirmed cases of Campylobacter infection in Maryland between 2007-2016 were linked by zip code with data from the Maryland well permits registry, the 2010 US Census and the USDA agricultural census. Campylobacteriosis incidence rates were calculated by zip code and a multivariate, negative binomial regression model was used to evaluate the association between private wells and the incidence of campylobacteriosis. Results: From 2007-2016, a total of 5,746 cases of campylobacteriosis were reported in Maryland, and annual incidence rates ranged from 6.65 to 11.59 per 100,000 people. A significant positive association was detected between number of private wells in a zip code and the risk of campylobacteriosis (Incidence rate ratio =1.033; 95% CI =1.0005, 1.0666). Similarly, the presence of broiler chicken operations in zip codes was also associated with campylobacteriosis incidence (IRR=1.286; 95% CI=1.0898, 1.5195). Conclusion: This project provides evidence that drinking water source may be an important risk factor for campylobacteriosis in the State of Maryland.

## **P01.2900. Health Impact Assessment and the Relationship with the Environment: An Integrating Review**

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**Abstract:** Objectives To identify the approach of scientific literature on Health Impact Assessment related to the environmental theme. Method Integrative literature review with search for studies with the terms health impact assessment and environment in the Portal of Periodicals of the Coordination of Improvement of Higher Level Personnel following the steps of the protocol elaboration and external validation, data collection, selection and critical evaluation of the studies, analysis of data and results that were organized into thematic categories. Results 38 studies were included, and the period with the highest number of publications was between 2012 and 2014, with studies developed mainly in Europe and North America. The categories that resulted were the practice of Health Impact Assessment, Health Impact Assessment and Urban Planning, Environmental Impact Assessment and Health Impact Assessment and Environment and Health. Conclusions The Health Impact Assessment is an important decision-making process, evidencing the need to expand its scientific production, discussions and results on the evaluation of health impacts of enterprises, public policies or programs resulting from the process of economic development. There is a movement for the inclusion of health in all policies, including in defense of the institutionalization of the integration between health impact assessment and environmental impact assessment, since it already has its consolidated legal base.

## **P01.2910. Alternatives Assessments for Hazardous Chemicals in Children's Consumer Products: Can Predictive Toxicology Tools Help?**

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**Abstract:** Exposure to toxic chemicals in consumer products can have lasting impacts on children's health due to their increased vulnerability during sensitive periods of development. Regulation and reporting requirements have increased demand for safer alternatives. This project examines how predictive toxicology tools can fill data gaps in alternatives assessments for hazardous chemicals found in children's consumer products. Data available from European Chemical Agency's (ECHA) Endocrine Disruptor Substances of Concern classification was compared with predictive toxicology tools that rely on in silico and in vitro data: The toxicological prioritization index (ToxPi), calculated based on information in the US EPA's ToxCast Database; and exposure rankings developed in the high throughput exposure screening program., ExpoCast. Three chemical groups were considered: phthalates, parabens and bisphenols. Only one out of the 24 alternative chemicals had data available through ECHA, yet in vitro data from ToxCast was available for 83% of alternative chemicals and animal in vivo data from the Comptox Chemistry Dashboard was available for 66% of alternative chemicals. The No Observable Adverse Effects Levels derived from the in vivo studies were higher for alternative than conventional chemicals, suggesting the alternatives may be less toxic. ToxPi scores, however, showed little difference between conventional and alternative chemicals. ExpoCast rankings were available for 20 of the 24 alternative chemicals. The rankings indicated that conventional chemicals have higher predicted exposure than alternatives. The results from this case study suggest that predictive toxicology tools can help fill data gaps when existing classifications are incomplete. This project is supported by the US EPA (FP-91779601-0, RD 83573801, RD 83451401) and the US NIEHS (5P01ES009601). The views expressed in this paper are those of the authors and do not necessarily reflect the views of the US EPA.

## **P01.2930. Arsenic Bioconcentration in Freshwater Fish Species in a Pristine Lake in Yellowknife, NT**

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Abstract: Yellowknife hosts one of the largest gold mining industries in Canada, including the renowned Giant Mine actively operating from 1948 to 2004, The mining operation in Giant Mine released enormous amounts of arsenic trioxide dust to the environment from the burning of arsenopyrite ores necessary to extract gold. Studies have revealed up to 100-fold increases in the concentration of arsenic in the surface water of lakes located within a 5-km radius of the mine. We summarized different factors from previous studies that contribute to the high arsenic levels found in lakes in Yellowknife: distance from the Giant Mine, prevailing wind direction to the Northwest, and the size of the lake. In this study, Small Lake was chosen as a pristine lake; a medium-sized lake located 27-km East of the mine and away from the city centre. Small Lake has the background concentration of arsenic of 1.4 µg/L in its surface water, unaffected by the historical activities from the Giant Mine. This background level of arsenic is expected from the slow natural weathering process of the bedrock geology. We collected two most common freshwater fish species in lakes in Yellowknife: Adult Lake Whitefish (*Coregonus clupeaformis*) (n=8) and adult Northern Pike (*Esox lucius*) (n=8). Total arsenic concentration in the tissues was measured using ICP-MS method following FDA standard. Results show arsenic concentrations of  $0.567 \pm 0.216$  mg/kg dry weight in the muscle tissue of Lake Whitefish and  $0.458 \pm 0.115$  mg/kg dry weight in the muscle of Northern Pike. Although the Northern Pike species in this study is in a higher trophic position than the Lake Whitefish species, no significant difference in the arsenic concentration is observed in the muscle tissues ( $p > 0.05$ ). The results of this study serve as reference data for fish arsenic monitoring programs and risk assessment projects in Yellowknife.

## **P01.2950. Incorporating Unique Exposure Pathways of the Diné People into a Community-Based Probabilistic Risk Assessment Following the Gold King Mine Spill**

Yoshira Van Horne

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Abstract: On August 5th 2015, the Gold King Mine Spill released 3 million gallons of acid mine drainage-containing arsenic (As) and lead (Pb) into a tributary of the San Juan River, which flows through the Navajo Nation. The Diné (Navajo) rely on this River and use it for a variety of purposes lending to unique exposure pathways. We administered questionnaires in three Navajo communities in collaboration with the Navajo Nation Community Health Representatives to obtain frequency and duration data on 42 activities. These activities were utilized to conduct a community-based probabilistic risk assessment from exposure to As and Pb: 1) before the Spill, 2) during peak of the Spill, and 3) one year after the Spill. To estimate exposure to As and Pb before the Spill, we utilized historical surface water (n=32) and sediment data (n=20) obtained from the USGS. Estimation of exposure to As during peak Spill incorporated As and Pb surface water (n= 92) and sediment (n=75) concentrations obtained from U.S. EPA publically available data. To estimate exposure to As and Pb one year after the Spill, we collected surface water (n=101) and sediment samples (n=127) in these three Navajo communities within one year after the Spill. Surface water concentrations of As and Pb were significantly different between periods (p-value <0.0001), with concentrations highest during the peak of the Spill, followed by pre-Spill and post-Spill levels. Sediment concentrations were significantly different (p-value <0.0001), but with concentrations highest before the Spill, followed by peak-Spill, and post-Spill. The risk assessment for arsenic and lead through these unique water/sediment pathways indicate both potential chronic and carcinogenic risks to the local Diné community. This research provides the first documentation of unique exposure pathways of the Diné people and raise the need to understand and document unique exposure pathways of indigenous communities with subsistence and land-based livelihoods.

## **P01.2960. The Importance of Developing Exposure Factors Handbook in Nigeria**

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Abstract: As environmental conditions continue to change and deteriorate, the residents in African Countries such as Nigeria have become increasingly threatened by continuous exposure to contaminants in gradient concentrations but with little or no adherence to environmental regulations by the government. Nigeria is also facing with great increase in number of potential health risk associated with environmental contamination with the UN projection on increase in population. It is now imperative that the government, regulatory bodies, scientist, industrialist and general public are aware of the dangers that contaminated soil, water, air, foodstuffs, and consumer products pose to humans and the ecosystem and how to manage these risks to protect human and ecological health. However, as of the time of writing the paper, no Environmental regulatory agency in Nigeria has a complied data or handbook will serve as a national index for demonstrating the physiological, food ingestion, and behavioral characteristics of the Nigerian people so as to provide basic information for health risk assessment and risk management. Since African people have unique exposure patterns and specific time-activity owing to the geological, social and economic difference, the existing Exposure Factors Handbooks in North American, Europe and other countries as USA, Canada and China cannot be used in evaluating the risks of Nigerian population. It is thus imperative to develop Exposure Factor Handbook to provide basic information for health risk assessment and to enlighten and sensitize Nigerians on the risks of environmental and health hazards. The paper highlights the significance of exposure factor handbook, the need for Nigeria to join list of countries with exposure factor handbook.

## **P01.2970. Propensity Score Matching in Environmental Epidemiology: A Systematic Review and Reporting Recommendations**

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**Abstract:** Background: Propensity score matching (PSM) is a statistical technique from econometrics to simulate a randomized trial in observational data. This method allows researchers to create a sample where exposed and unexposed groups probabilistically differ only on exposure status. Although PSM has recently increased in popularity, there is little guidance for environmental researchers on applying this technique and transparently reporting the results. Methods: We conduct a systematic literature review via PubMed and Web of Science to find epidemiological articles that used PSM for an environmental exposure with a chronic disease outcome. Using established reporting standards from econometrics, we assess PSM methods used and transparency of reporting for each article. We then demonstrate the need for sensitivity analyses of PSM using traffic-related air pollution and term birth weight to highlight unique PSM challenges in environmental settings. Finally, we create a reporting checklist for researchers who want to use PSM in their own work. Results: We found 37 studies that met our search criteria. Little consistency exists regarding what is reported and how PSM is conducted. Our example using traffic-related air pollution and term birth weight demonstrates that PSM results are sensitive to matching criteria and statistical specification. Recommendations: We propose that studies report three specific metrics to demonstrate that effective PSM occurred: 1) A figure showing the propensity score distribution of units between exposed and unexposed groups; 2) A table exhibiting covariate distributions before and after matching with appropriate bias calculations; and 3) Sensitivity analyses of final PSM results using different matching schema to demonstrate robustness. Conclusion: PSM has potential to be a powerful tool for environmental epidemiology, but transparent reporting methods and robustness checks are needed to ensure that PSM is being correctly applied.

## **P01.2980. Phthalate and Organophosphate Plasticizers in Nail Polish: Evaluation of Ingredients and Labels**

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**Abstract:** In the last decade, nail polish manufacturers largely phased out use of the three widely publicized "toxic trio" chemicals, including the plasticizer dibutyl phthalate (DnBP). These "3-Free" nail polishes may instead contain the plasticizer triphenyl phosphate (TPHP), a possible endocrine disruptor. Nail polish users and majority-Vietnamese nail salon workers in the U.S. are vulnerable populations potentially exposed to these plasticizers. To better understand plasticizer ingredient substitution, this study aimed to 1) identify plasticizer-related nail polish product labels through online searches, and 2) measure levels of 12 phthalate and 10 organophosphate plasticizers in 40 nail polishes. The 40 samples comprised different colors from 12 brands selected based on popularity and label variety. Summary statistics and Wilcoxon rank sum tests were calculated for plasticizer levels, substituting half the detection limit for non-detect values. We identified 11 n-Free labels ranging from 3-Free to 13-Free that reported the exclusion of n ingredients, with 5-Free the most common. The label definitions varied by brand, with 6 different definitions of 10-Free. Over half of nail polishes 6-Free or higher advertised the exclusion of TPHP. For the 40 samples, concentrations reached up to 7940 µg/g for organophosphates (TPHP) and 331 µg/g for phthalates (bis[2-ethylhexyl] phthalate [DEHP]). All DnBP levels were below 0.5 µg/g. TPHP levels were statistically lower in the 28 newer generation 5- to 13-Free samples compared to the 12 conventional or 3-Free samples (median 0.001 vs. 3730 µg/g,  $p < 0.001$ ). DEHP levels were statistically higher for the 16 nail polishes without detection of TPHP than the 24 with detection (68.5 vs. 1.51 µg/g,  $p < 0.05$ ). In conclusion, the evolving nail polish labels are varied and diversely defined. Our results suggest that DnBP and TPHP are now excluded or reduced from many polishes, but some concerns about plasticizer ingredients remain.

## **P01.2990. Refine Health Benefit Prior-Evaluation of Emergency Response Measures Under Heavy Pollution Weather**

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**Abstract:** In a realistic scenario people move and get exposed to different microenvironment (ME) with varying PM<sub>2.5</sub> levels. While the traditional health impacts assessment directly overlaid static population with ambient PM<sub>2.5</sub> concentrations, without considering diverse individual Activity Patterns (AP), bringing great uncertainties in PM<sub>2.5</sub>-related mortality burden assessment. So to refine exposure assessment considering AP, and applied it to the assessment of the Emergency Response Measures (ERMs) for heavy pollution weather. We carried out Activity Pattern Survey (APS) to investigate the time spent in certain ME and on certain activity types. Based on population density maps and APS data, the Random Forest Model and Agent Based Model were used to establish the rules of individual activity decisions and simulate the Population Distribution Embedded with AP (PD-AP), respectively. Then, indoor/outdoor PM<sub>2.5</sub> concentration ratios of ME were summarized through literature research and were applied to calculate the ME PM<sub>2.5</sub> levels by modifying the ambient PM<sub>2.5</sub> levels. Finally, based on PD-AP, ME PM<sub>2.5</sub> levels, and doses-response relationship, we used the Relative Risk Model to evaluate PM<sub>2.5</sub> attributed deaths under 8 ERMs. And we also compared results under PD-AP, Uniform Population Distribution (UPD) and Static Population Distribution (SPD), to figure out the importance of improving simulation ability of the real distribution of population. The traditional UDP and SDP methods overestimated PM<sub>2.5</sub> attributed deaths, and this overestimation was far greater than changes of attributed deaths caused by choosing different ERMs. Therefore, it is of great importance of considering diversities of population AP for improving accuracy of PM<sub>2.5</sub> exposures assessment. Among 8 ERMs, Intensified Control Scenario in Jiangsu should be selected to deal with heavy pollution weather for its maneuverability and good performance of reducing attributed deaths especially in highly polluted areas.

## **P01.3000. Affecting Factors of Exposure to Influential Factors Assessment for Humidifier Disinfectant Victims in Korea**

Hyeon-Su Ryu

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Abstract: Health adverse effect such as lung disease caused by chemical substances (PHMG, PGH, CMIT/MIT) used in humidifier disinfectants occurred in Korea. 6,005 of requests have been registered up to March 30, 2018 including 1,320 of the dead since 2011 when environment exposure survey has begun. Ministry of Environment of Korea (ME) has conducted comprehensive judgment including medical and environment exposure assessment for victims to evaluate lung disease and causal relationship by exposure to humidifier disinfectant, and organized the Expert Judgment Committee, and conducted a comprehensive judgment. Relationships between exposure characteristics such as ingredient of product, use amount, and use characteristics and health effects were conducted for 2,203 victims from 2011 to 2017 by using of exposure questionnaire. The categories that recorded in survey such as daily using time, cumulative time, using time during sleep, distance from respiratory organ, spraying direction, concentration in the air, exposure level of humidifier disinfectants were scored and exposure levels were graded. We assessed the characterization of exposure to humidifier disinfectants for victims using questionnaire survey, and classified the exposure levels into 5 grades such as definite, probable, possible, indeterminate and unlikely. As victim register order increase, the rate of victims of grade 'definite' decrease. There were differences between scored exposure grades and final judgements. The statistical test shows differences in results of comprehensive judgment and environment exposure assessment. It can be explained by the records of the questionnaire on past exposures may be uncertain due to recall bias or psychological effects. If the various health effects data of the humidifier disinfectant victims are analyzed, the users with similar conditions of the humidifier usage characteristics might be grouped to inspect the health effect based on the exposure assessment results.

## **P01.3010. Quantifying Environmental Costs for Sustainable Pavement Management**

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**Abstract:** We quantify the effect of Ontario's provincial transportation infrastructure decisions on multipollutant exposures, impacts, and life-cycle costs. A variety of evidence shows that roadway construction and maintenance affect human health and climate change via emissions of air pollutants and greenhouse gases. With recent policy shifts, provincial transportation decision-makers are focused on the role of roadway design and maintenance on these environmental exposures; however, they lack appropriate tools to incorporate them into decisions. Here, we present a decision-making tool that quantifies the health, environmental, and economic impacts of construction, maintenance, and rehabilitation of roads and highways. We examine various pavement design and management approaches, including standard practices, and innovations to processes and materials. We estimate multipollutant emissions, including (CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, PM<sub>2.5</sub>, CO). We review literature that connects these exposures to health and economic impacts directly through marginal damage estimates. Current literature estimates for the cost of emitting a single metric tonne of fine particulate matter range between \$600 and \$50,000 (2010 CAD) depending on the impacts considered and the cost measures used. Preliminary findings for environmental costs of emissions from new-construction of a double-lane, one-kilometre road range between \$300 to \$50,00 for asphalt roads and \$3000 to \$400,00 (2010 CAD) for concrete roads. In this research, we expand on these findings and quantify contributions of uncertainty from exposures, exposure-response, and economic impacts. These findings allow infrastructure managers to account for health-related impacts of environmental exposures, including air pollutants and greenhouse gases, and thus to design more sustainable solutions.

## **P01.3011. Comparisons of Prevalence and Determinants of COPD between Northern and Southern China**

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**Abstract:** Under-diagnosis of chronic obstructive pulmonary disease (COPD) exists extensively due to the absence of the symptom in early stage. Associated social and environmental factors could be utilized to predict the risk of COPD for the early detection. Although COPD prevalence presented significant geographic variations indicating the possible influence of climate and socio-ecological determinants, little research has been done to explore the relative importance of these determinants among different geographic areas. This study aims to identify the relative importance of the determinants and assess their difference between northern and southern China. Data were collected from the nationwide COPD survey which enrolled 66752 adults from 125 counties over 31 provinces in China. All the participants completed a questionnaire and spirometry. Multiple logistic regression model showed that COPD prevalence in southern China was significantly lower than that in northern China (Odd Ratio: 0.8; 95% confidential interval: 0.8-0.9) after adjusting for social and environmental factors. The classification and regression tree (CART) model showed that the most important determinant for COPD was cigarette smoking followed by age ( $\geq 60$  years), and then asthma history in the north, whereas the most important determinant in the south was age ( $\geq 61$  years) followed by cigarette smoking, and then dyspnea. In the north, for participants with the highest risk, the prevalence of COPD (64.0%) was 4.8 times that of the general population (13.3%). In comparison, the prevalence of participants with the highest risk (57.2%) was 4.1 times that of the general population (14.0%) in the south. The determinants for COPD prevalence, their relative importance and the threshold varied between north and south. These results should be used in the primary care in the north and south to assist in early detection of COPD. Further research is needed to explore the ranking of determinants in different climate zones.

## P01. Occupational Issues 1

### **P01.3020. Biomarker Based Occupational Exposome**

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Abstract: Occupational exposures are thought to be responsible for over 370,000 premature deaths each year. Thus, the precise quantification of occupational exposure is necessary to consider in understanding an individual's exposome, the entirety of chemical exposures in a lifetime. Using the National Health and Nutrition Examination Survey (NHANES) of 220 chemical biomarker concentrations measured in 52,355 participants, we implemented an untargeted approach to systematically contrast occupational exposure differences between blue-collar and white-collar workers, which were defined based on participants' job descriptions. We conducted a series of multiple regression models with chemical biomarker levels as the outcome variable and blue-versus-white-collar categories as the main predictor while adjusting for age, race, gender, smoking, and poverty-income ratio. Cotinine, a biomarker of smoking, is of the highest concentrations in blue-collar workers in industry (295% higher compared to white collar workers) and in blue-collar workers in non-industrial settings (101% higher compared to white collar workers). Industrial blue collar workers have on average more than 27% higher levels of 3-fluoranthene, lead, and pentachlorophenol compared to white collar workers, and non-industrial blue collar workers have on average more than 20% higher levels of pesticides such as p,p'-DDT, Beta-Hexachlorocyclohexane, and DEET acid compared to white collar workers. Compared to industrial blue-collar workers, white collar workers have on average more than 15% higher levels of personal care product related chemicals such as BP-3, Triclosan, and Ethyl paraben. Systematically studying the NHANES chemical biomarkers and occupational datasets by implementing an untargeted approach enables the identification of expected and unexpected exposure differences by job categories. These findings can be utilized to prioritize chemicals and workers for toxicological evaluation or health interventions.

## **P01.3030. The Impact of Heatwaves on Workers' Health and Safety in Australia: A Multi-City Study**

Blesson Varghese

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**Abstract:** Heatwaves are predicted to increase in frequency, intensity and duration with climate change, and outdoor workers will be particularly vulnerable. This study examined the relationship between heatwave severity and work-related injuries to better define impacts in Australia and identify workers at highest risk. Workers' compensation claims lodged in Brisbane, Melbourne and Perth were obtained for the years 2006-2016. Heatwaves were defined using the Excess Heat Factor, a normalised metric to measure heatwave severity across different climatic regions. Associations between heatwave severity categories (low, moderate and high) and workers' compensation claims stratified by demographic and injury characteristics were estimated using a time-stratified case-crossover models. Non-uniform impacts were observed in subtropical (Brisbane) and temperate cities (Melbourne and Perth). In Brisbane, there was a significant increase in compensation claims during moderate (RR 1.11; 95%CI 1.04-1.19) and high-severity heatwaves (RR 1.24; 95%CI 1.01-1.52). Vulnerable groups included: males, middle-aged and older workers, experienced workers, those in regulated indoor environments and those employed in medium and heavy strength occupations. In Melbourne, moderate-severity heatwaves were associated with an increase in minor injury claims ( $\leq 1$  week of time-loss, RR 1.18; 95%CI 1.02-1.37), while total claims declined during high-severity heatwaves. Young workers, those in unregulated indoor environments and outdoors had elevated risk during heatwaves. In Perth, moderate and high-severity heatwaves were associated with a decline in total claims (RR 0.91; 95%CI 0.85-0.98 and RR 0.86; 95%CI 0.81-1.13). These findings show that heatwaves are associated with increased occupational injuries for both indoor and outdoor workers. However, impacts can vary across cities in different climatic regions, suggesting that region-specific injury prevention interventions may be appropriate during heatwaves.

## **P01.3040. Night Shift Work and Placental Methylation in the Rhode Island Child Health Study (RICHS)**

Danielle Clarkson-Townsend

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**Abstract:** **ABSTRACT** Background: The circadian clock produces cycles of rhythmic biological activity, but disruption of the circadian clock can impact health. Rationale: Exposures that cause circadian disruption, such as night shift work or light at night exposure, are incredibly common, yet little is known about how they impact in utero development. Methods: We investigated whether placental methylation (measured with Illumina 450k array) differed between non-night shift workers (n=184) and night shift workers (n=53) in the Rhode Island Child Health Study (RICHS). We used robust linear modeling to conduct an epigenome-wide association study of night shift work, including covariates for putative cell mixture, maternal age, prepregnancy smoking, infant sex, and maternal adversity. Results: Night shift workers tended to have higher BMI and gestational diabetes compared to non-night shift workers. 10 CpG sites showed differential methylation in night shift workers after Bonferroni adjustment for multiple comparisons ( $p < 0.05$ ). The CpG sites with the most hypomethylation were within NAV1, MXRA8, GABRG1, PRDM16, WNT5A, and FOXG1, while CpG sites with the most hypermethylation were within TDO2, ADAMTSL3, DLX2, and SERPINA1 ( $q < 0.10$ ). PER1 was the only core circadian clock gene demonstrating differential methylation. An analysis of differentially methylated regions (DMRs) indicated DMRs in the NAV1, PURA, C6orf47, and GNAS genes ( $q < 0.10$ ). KEGG pathway and GO-term analysis indicated GO-terms related to cell-cell adhesion. Conclusion: Altered placental methylation, particularly within the neuron navigator 1 (NAV1) gene, was associated with night shift work. Nav1 displayed rhythmicity in mouse SCN tissue, so it may play a role in the circadian clock. Circadian disruption may be an important developmental exposure and future studies should evaluate the impact of shift work on fetal development. Further research should also evaluate shift work as a risk factor for gestational diabetes.

## **P01.3050. Outsourcing Informal Home Workers in Jewelry and Fashion Jewelry Production Present High Prevalence of Preterm Birth**

Flávia Vieira

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Abstract: Limeira is a Brazilian municipality with 276,000 inhabitants and human development index of 0.775, where is located an important jewelry and fashion jewelry local productive arrangement (LPA). Part of this LPA encompasses precarious and outsourcing informal home practices, which exposes the working families to potentially toxic elements (EPTs: Cd, Cr, Cu, Hg, Ni, Pb, Sn, and Zn). The aim of this study was to compare the prevalence of diseases/health endpoints, which can be related to EPTs exposure, between informal home workers and their relatives, and controls. A cross-sectional study was carried out with exposed group (outsourcing informal home workers and their families, 29 families), and control group (neighbors who did not work with EPTs exposure, 23 families), totaling 254 individuals. A questionnaire on referred diseases, adapted from the household survey of the Brazilian National Cancer Institute, was applied, in order to explore the health perception and referred diseases in this population. For the data analysis, chi-square and Fisher tests were applied ( $p < 0.05$ ). Both exposed and control groups were similar for age, schooling, medication and supplements use, and consumption of alcohol and tobacco ( $p > 0.05$ ). The groups were then categorized according to age (adults and elderly) and women of childbearing age (10 to 49 years). It was observed a higher prevalence of neurological (47.3%), psychiatric (26.4%) and respiratory (34%) diseases in the exposed group, but the statistical differences were not significant. In addition, a statically significant higher prevalence of preterm birth was found for exposed women ( $p = 0.045$ ). The results of this study emphasize the importance of understanding the exposome of the population. Occupational exposure scenarios inside homes should be taken into account to implement public policies to protect the population, especially child-bearing age women. This study was funded by FAPESP (Grant 2016/11087-8) and CAPES.

**P01.3060. A Pilot Project Assessing Exposure of Livestock Workers in the Southwest U.S. to E.Coli O157:H7 and Salmonella**

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Abstract: The livestock industry, like many other agricultural industries in the United States, is dependent on the labor that migrant and seasonal farm workers (MSFW) provide. Infections caused by zoonotic pathogens are commonly underreported or misdiagnosed, and possibly more so in migratory populations that face cultural, structural, legal, financial, and geographic barriers to health services. The objectives of this project were to: Assess feasibility of collecting and analyzing infectious pathogens; inform future risk assessment models; and encourage livestock worker health and safety. Swab samples were collected from the shoulders, knees, and foreheads of employees at two livestock operations at the end of work shift (n=20). The swabs were cultured for E.coli O157:H7 and Salmonella. Molecular Salmonella DNA was extracted and quantified using droplet-digital Polymerase Chain Reaction (ddPCR). Additionally, a questionnaire including demographics, work tasks, and health and safety practices was administered to all participants. E.coli O157:H7 was detected in 13% of cultural environmental samples and Salmonella was detected in 3% of cultural environmental samples. Molecular Salmonella DNA was quantified in 60%, 40% and 15% of samples collected from workers' foreheads, shoulders, and knees, respectively. The majority of participants spoke Spanish and had completed some high school. Finally, all participants reported wearing gloves, an apron, and boots during the workday. The questionnaire provides insight that can be used to create appropriate recommendations for the livestock industry, workers, and workers' families. The positive cultural and molecular samples indicate the need for improved sanitation practices at farms, utilizing the industrial hygiene hierarchy of controls. This pilot project informs future investigations, helps build risk assessment models, improves worker knowledge and health, and fosters preventive practices in the Arizona agricultural industry.

## **P01.3070. Volatile Organic Compound Exposure in Colorado Nail Salons**

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Abstract: A pilot study of Volatile Organic Compound (VOC) exposure was conducted in 6 nail salons along Colorado's front range. Measurements included area concentrations of Total VOCs (TVOCs), Formaldehyde (HCHO), Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), as well as personal exposure sampling of four additional VOCs and worker health surveys. Preliminary data includes average TVOC levels between 3ppm and 22ppm, average HCHO levels between 12ppb and 405ppb, and BTEX concentrations between 23ppb and 300ppb. All participating salons exceeded the NIOSH standard for 8hr time-weighted HCHO concentration on at least one measurement day, and several salons exceeded other HCHO standards including the ACGIH 8hr Threshold Limit Value (TLV). BTEX concentrations observed were similar to those measured in previous occupational exposure studies of gasoline and diesel station attendants and oil refinery workers. Most (65%) survey respondents reported experiencing at least one health symptom as a result of their employment in the nail salon industry, with the most common symptoms including headaches, skin irritation, eye irritation, and nose irritation. Cancer risk estimates for Benzene and Formaldehyde exposure were calculated using cancer slope factors published by the United States Environmental Protection Agency (US EPA) in their Integrated Risk Information System (IRIS). These estimates are based on a 30-year occupational exposure duration, and incorporate average body weights provided by the Center for Disease Control (CDC), as well as inhalation rates provided by US EPA. The elevated lifetime risk for Squamous Cell Carcinoma (SCC) from formaldehyde exposure ranged from approximately 1 in 100,000 ( $1.18 \times 10^{-5}$ ) to over 6 in 10,000 ( $6.5 \times 10^{-4}$ ). The elevated lifetime risk for Leukemia from benzene exposure ranged from  $5.15 \times 10^{-7}$  to  $5.05 \times 10^{-5}$ .

## **P01.3080. Exposure of Nail Salon Workers to Phthalates and Organophosphate Esters**

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Abstract: Nail salons are one of the fastest growing industries in the USA; there is concern about health impacts associated with nail salon exposures in a vulnerable, largely immigrant worker population. Nail technicians are exposed to semi volatile organic compounds including phthalates and organophosphate esters (OPEs). In this pilot study we collected spot urine samples during one work shift from 10 female nail technicians in the Boston (USA) area in 2016-17. We assessed occupational exposures using urinary biomarkers in pre- and post-work shift samples; we compared post-shift concentrations with the general US female population from the National Health and Nutrition Examination Survey (NHANES) 2011-12 for phthalates, 2013-14 for OPEs. We detected 12 phthalate and 4 OPE urinary biomarkers in  $\geq 60\%$  of participants' samples. After creatinine correction, geometric mean (GM) post-shift concentrations were higher than pre-shift for all but one phthalate and one OPE biomarker. Triphenyl phosphate is used as a phthalate replacement in some nail polishes; the GM of its urinary metabolite increased slightly (23%) from pre- to post-shift; post-shift concentrations were slightly higher than NHANES females (17%). The greatest pre- to post-shift change was for mono-2-ethyl-5-carboxypentyl terephthalate (MECPTP), which more than tripled from 11.7 to 36.6  $\mu\text{g/g}$  creatinine. Phthalate biomarkers reported in both studies were lower in our study participants than in NHANES females. NHANES did not report MECPTP, a recent study found increasing trends from 2000-2016 of MECPTP in urine from a convenience sample of US adults. Di-2-ethylhexyl terephthalate (DEHTP), the parent compound of MECPTP, is a plasticizer used as a phthalate substitute in consumer products such as food packaging, toys, and perhaps nail polish. Our results suggest that nail technicians are occupationally exposed to certain phthalates and OPEs, with a urine metabolite of DEHTP showing the largest increase across a work day.

**P01.3090. Occupational Exposure in the Home Environment: An Investigation on Chemical Exposure of Outsourced Informal Working Families Involved in Jewelry and Fashion Jewelry Productive Chain**

Ana Paula Sacone da Silva Ferreira

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Abstract: The city of Limeira presents a relevant productive chain of jewelry and fashion jewelry, including a scenario of outsourcing informal home practices. It is highly complex to understand the potentially toxic elements (PTEs: Ni, Pb, Cd, Sb, Sn, Cu and Zn) exposures of the workers because this productive chain encompasses households. The aim of this study was to investigate the associations between blood PTEs levels (BEL) and informal work in the home environment. In addition, breathing zone air PTEs levels (AL) were measured in welders. This study included 52 families (n= 165), divided into exposed group (n=112) and control group (n= 53). Blood (n=165) of families and breathing zone air samples (n=9) of welders were collected and the PTEs concentrations were determined by inductively coupled plasma mass spectrometry (ICP-MS). Three questionnaires were applied to collect sociodemographic information as well as the details of the workplace conditions and materials used. The overall data were analyzed using principal component analysis (PCA) and analysis of variance (ANOVA). Additionally, a cluster analysis was performed to identify linkage between the data. Finally, multiple logistic regression analysis was carried out in order to gain further insight into a group of observations. We had 9 participants with Cd blood level quantified and the GM was 3.45 µg/L. Cadmium, Ni, and Cu showed AL values up to 10 times higher than occupational guidelines in the air samples analyzed. The results showed a significant difference in the blood Pb levels between exposed and control groups (p<0.05). The PTEs concentrations found in the air raise concern once the families, including children, are in the same exposure scenario. Inadequate work conditions were observed in the houses, revealing the need to implement urgent public actions in order to protect those worker families. This study was funded by FAPESP (Grants: 2016/07457-4;2016/11087-8; 2017/15797-2).

## **P01.3100. Urinary Metabolites of Organophosphate Esters (OPEs) in Electronic Waste Recycling Workers from the Province of Quebec, Canada**

Marc-André Verner

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**Abstract:** Background: Organophosphate esters (OPEs), which are used as flame retardants and plasticizers, have been measured in the air of electronic waste recycling (E-recycling) plants. Numerous studies suggest that exposure to OPEs may result in adverse health effects and constitute a potential health risk for E-recycling workers. However, data on urinary OPE metabolites in occupationally exposed workers is scarce. Objective: To measure urinary OPE metabolites in E-recycling workers and assess their relationship with personal air OPE levels. Methods: Levels of 13 OPE metabolites were measured, at the end of the work shift, in urine samples from 56 workers (four facilities in Quebec, Canada). Air levels of 11 OPEs were measured in 8-hour personal samples with OSHA XAD-2 versatile samplers. The relationship between air OPE levels and urinary metabolite levels was determined using Spearman's rank correlation. Results: Nine of the 13 urinary OPE metabolites were detected in more than 50% of samples. The OPE metabolites with the highest median levels were 1-hydroxy-2-propyl bis (1-chloro-2-propyl) phosphate (OH-BIPCPP) (median: 2.2 ng/mL; maximum: 26), diphenyl phosphate (DPhP) (median: 2.1 ng/mL; maximum: 19), bis(1,3-dichloro-2-propyl) phosphate (BDCIPP) (median: 1.2 ng/mL; maximum: 7.4), and bis(2-chloroethyl) carboxymethyl phosphate (tris(1,3-dichloro-2-propyl) phosphate (BICECMP) (median: 0.5 ng/mL; maximum: 16). Urinary OPE metabolite levels were not significantly correlated with air OPE levels ( $p$  values were above 0.05). Discussion: The median urinary levels of BDCIPP and DPhP were higher than those observed in workers from a Chinese E-recycling site, although the timing of sample collection differed. These findings suggest that workers from E-recycling plants are exposed to OPEs, but that exposure through routes other than inhalation, and possibly non-occupational sources, may be more important contributors to the absorbed dose.

## **P01.3110. Passive Air Sampling for Gaseous Mercury in Workplace Atmospheres and for Personal Inhalation Exposure Monitoring**

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Abstract: Inhalation exposure to gaseous elemental mercury (GEM) continues to be a concern in a number of workplaces. Examples are facilities handling mercury-containing electronic waste, such as compact fluorescent light bulbs, or so-called "gold-shops" processing the amalgams from artisanal and small-scale gold mining operations. GEM is also often present near historically mercury-contaminated sites or in dental facilities, creating the conditions for low-level, chronic inhalation exposure. Considering that inhaled GEM is readily absorbed and transferred across the blood-brain barrier, there is a need to be able to measure its air concentrations reliably and continuously. We are therefore exploring the feasibility of using a passive air sampler (PAS) recently developed for recording long term average GEM concentrations in the ambient atmosphere in the monitoring of personal GEM inhalation exposure and GEM concentrations in workplace atmospheres. This PAS is small, light, inexpensive, easy-to-operate, and requires no power. By tightly controlling sampling rates through (i) the use of a radial porous diffusive barrier, and (ii) a wind shelter, the sampler achieves high precision and accuracy. Eliminating the PAS's wind shelter allows for its use as a wearable personal sampler, while only slightly increasing sampling rate variability. Average GEM concentrations need to be in excess of  $\sim 20$  ng/m<sup>3</sup> for the PAS to take up sufficient GEM during an 8-hour workday to achieve reliable quantification. For a 40-hour sampling period, corresponding to a traditional workweek, the threshold drops to  $\sim 5$  ng/m<sup>3</sup>. At higher GEM concentrations, (i) even shorter sampling times are achievable, and (ii) a thicker diffusive barrier can be used, which increases precision by better controlling sampling rates. Side-by-side comparisons of the PAS in a number of occupational settings with personal pumped samplers support the validity of using occupational exposure estimates acquired with a PAS.

## **P01.3120. Occupational Safety in Academic Research Laboratories: Identifying Upstream Risk Factors**

Katrina Burns

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**Abstract:** **BACKGROUND:** Fatalities and serious injuries in academic research laboratories have resulted in publications of recommendations on reinforcing safety culture, compliance, and safety behaviors in this work environment. However, no systematic review of peer-reviewed literature on academic research laboratories exist. **OBJECTIVES:** This review assesses literature on U.S. university research laboratories from 2008 through 2017, tort case decisions, and incident investigation results by comparing to the current recommendations for improving safety culture in academic research laboratories from the National Research Council (NRC), American Chemical Society (ACS), and Association of Public Land Grant Universities (APLU). **METHODS:** Search terms derived from three publications were entered in PubMed, ProQuest, and Web of Science databases. A scoping review was used to map the studies related to this topic. Google Scholar was used to find tort cases. Incident investigation results were found through published news articles or on the Occupational Safety and Health Association (OSHA) website. **RESULTS:** 223 peer review articles were found; 5 articles on specifically referencing academic research laboratories, including seminal articles; 104 articles were focused on interventions in various work environments, including healthcare; 114 were nonintervention studies; 12 examples of tort cases involving academic research laboratories were also found. **DISCUSSION:** The literature on occupational safety in academic research laboratories is relatively sparse, not surprising given evidence that adverse safety incidents and near misses are under-reported in these settings, and incentives to improve safety culture and establish safety management systems are lacking. However, literature representing other work environments identified additional upstream factors useful for a framework on promoting safety culture in the academic research laboratory workforce.

**P01.3130. Associations between Psychosocial Working Environments and Nurses' Eating Behaviors in Taiwan: A Pilot Study**

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**Abstract:** Background: Previous studies revealed that psychosocial working environments (e.g., occupational stress, and shift work) might contribute to workers' unhealthy eating behaviors. However, the effects among hospital nurses working a shift work pattern remain inconclusive. Objective: To examine the associations between nurses' psychosocial working environments and their eating behaviors. Method: Using a cross-sectional study design, a mailed structured self-administered questionnaire was administered to collect RNs' exposures to psychosocial working environments (i.e., perceived occupational stress, nurse-patient ratio, and weekly working hours) and their eating behaviors during a typical shift (i.e., customized handmade drinks, sweetened beverages, and sweetened food). Multivariable logistic regressions were employed to analyze associations between RNs' psychosocial working environments and eating behaviors. Results: A total of 509 questionnaires were eligible for the final analysis. The prevalence rates of RNs' customized handmade drinks, sweetened beverages, and sweetened foods intake during their typical shifts were 77.2%, 55.8%, and 50.7%, respectively. Unexpected work-related events during shifts were significantly associated with RNs' consumptions of customized handmade drinks (AOR: 1.7, 95% CI: 1.1, 2.6) and sweetened beverages (AOR: 1.7, 95% CI: 1.1, 2.4). RNs working more than 48 hours weekly were at a higher likelihood of sweetened beverage consumptions (AOR: 1.8, 95% CI: 1.1, 2.9). Unreasonable nurse-patient ratio (AOR: 1.4, 95% CI: 1.0, 2.5) and perceived occupational stress (AOR: 2.0, 95% CI: 1.2, 3.7) were associated with RNs' sweetened food intakes. Conclusion: This study revealed that psychosocial working environments were related to hospital RNs' certain types of food intakes during their typical shifts. Strategies to reduce hospital RNs' care burden and demands may be beneficial in improving hospital RNs' food choices.

**P01.3140. Urinary MDA and 8-OHdG Concentrations among Agricultural Workers in South Korea and Influence of Protective Measures**

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Abstract: Pesticides increase the quality of agricultural products, however routine exposure to these chemicals can result in adverse chronic health effects. Oxidative stress biomarkers such as malondialdehyde (MDA) and 8-hydroxy-2'-deoxyguanosine (8-OHdG) have been used to link pesticide exposure with the risk of chronic diseases such as cancer and neurological diseases. In the present study, the levels of MDA and 8-OHdG were analysed in urine samples collected from agricultural workers in South Korea. The influence of wearing personal protective equipment and performing protective behaviors on the levels of these two biomarkers was also evaluated. The median levels of MDA and 8-OHdG in urine samples were 9.37 nmol/mg creatinine and 19.06 ng/mg creatinine, respectively. In general, the levels of MDA and 8-OHdG were higher in male farmers. Wearing greater numbers of personal protective equipment and performing more protective behaviors was significantly associated with lower levels of MDA and 8-OHdG. The results indicate that pesticide exposure could cause oxidative stress and DNA damage in agricultural workers, and protective measures are important for reducing the levels of MDA and 8-OHdG.

## **P01.3160. Artisanal Tanning Industry and Health in Bogota, 2017**

Danyver Carreazo Vasquez

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**Abstract: SUMMARY** The process of tanning, which transforms animal skin into leather through the application of chemical products, can have deleterious effects on human health. Half of tannery factories in Bogotá are not legally registered so there is a lack of control on the use of harmful substances in the process as chromium or phthalates. This study was conducted to identify health effects associated with environmental exposure to substances produced by the tanning industry in San Benito, which is a community with high concentration of tannery factories in Bogota. Cross-sectional study, sample of 265 people from San Benito neighborhood (exposed) and another not exposed neighborhood. Exposure criteria was defined as proximity to the tanning industry in a radius of 300 meters. Outcome measures were dermatological, respiratory and neurological sentinel symptoms and diseases related to the exposure. Data was collected via survey through an instrument validated both by experts and statistically. Statistical analysis included the calculation of prevalence ratio and confidence intervals. Statistically significant associations were observed for chronic bronchitis (PR: 1.39 IC95%: 1.05-1.84), contact dermatitis (PR: 1.19, 95% CI: 0, 75-1.90) migraine (PR: 1.30 IC95%: 1.30-1.65), nasal congestion (RP: 1.71, 95% CI: 1.19-2.47), cough with phlegm (RP: 2.04 IC95%: 1.19-3.50) and headache (RP: 1.30 IC95%: 1.03-1.65). An excess morbidity was observed in highly exposed population. Further studies should examine the causal effect of specific toxic substances on population health.

## **P01.3170. Acute Pulmonary Responses among Wildland Firefighters following Exposure to Wildland Fire Smoke**

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**Abstract:** Background: Wildland firefighters are repeatedly exposed to elevated levels of wildland fire smoke (WF smoke) while protecting lives and properties from wildland fires. Although association between WF smoke exposure and spirometric changes has been reported in a few epidemiological studies, knowledge of pulmonary biochemical changes underlying such physiological response is still limited. Studies using nasal or sputum lavage for investigating pulmonary effects indicate WF smoke exposure can induce oxidative stress and inflammation among the firefighters. However, these collection methods are either non-representative or invasive. Methods: In the present study, exhaled breath condensate (EBC), a non-invasive collection method, was used to determine pulmonary responses among wildland firefighters working at prescribed burns. Twelve firefighters were recruited from US Forest Service-Savannah River Site. EBC was collected before (pre-shift), immediately after (post-shift), and morning after work shifts for measuring oxidative stress (8-isoprostane) and pro-inflammatory responses (Interleukin-8 [IL-8]; C-reactive Protein [CRP]; and Intercellular Adhesion Molecule 1 [ICAM-1]). Linear Mixed Effect Model was used to determine ratio of post to pre-shift and ratio of morning after to pre-shift of the biomarkers. Results and conclusions: Marginally significant increases were observed from pre- to post-shift for sICAM-1 (4%; p-value = 0.08) and 8-isoprostane (9%; p-value = 0.09). No other significant changes of the biomarkers were observed. Results suggest that WF smoke exposure causes mild pulmonary responses among wildland firefighters as indicated by small increases in the levels of sICAM-1 and 8-isoprostane following exposure. Results from this study might indicate the mechanism underlying lung function decline or systemic responses reported by epidemiological studies investigating association between WF smoke exposure and acute health effects among the firefighters.

**P01.3171. Influence of Genetic Variance on Occupational Exposure to 1,6-Hexamethylene Diisocyanate (HDI) and Its Trimer HDI Isocyanurate**

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Abstract: Polyurethane spray-painting can result in significant occupational exposure to 1,6-hexamethylene diisocyanate (HDI) monomer and its trimer, HDI isocyanurate. Inter-individual genetic differences have been linked with adverse health effects and asthma risk in isocyanate-exposed workers. However, little is known about inter-individual differences in response to HDI isocyanurate exposure compared to the HDI monomer. We are investigating the similarities and differences in exposure-dose responses and the genetic variants that modify or predict relationships between toxicokinetics and biomarker levels in exposed workers. Inhalation and skin exposure to HDI monomer and HDI isocyanurate were measured in 33 spray-painters along with the respective urine and blood biomarkers of 1,6-hexamethylene diamine (HDA) and trisaminohexyl isocyanurate (TAHI). Genome-wide microarrays (Affymetrix 6.0) were used to genotype the workers' single nucleotide polymorphisms (SNPs) and to conduct a genome-wide association study (GWAS). Using exposure values as covariates and a false discovery rate <0.20 for significance, GWAS showed that one SNP was associated with TAHI levels in urine, six SNPs were associated with HDA in plasma, and twelve SNPs were associated with HDA levels in urine. No SNP associations reached significance for TAHI levels in plasma. The SNPs were tested in linear mixed models (LMM) and bioinformatics data of the genes proximal to the top ten most significant SNPs for each compound were assessed for biological plausibility. Bioinformatics for HDI monomer associated SNPs included predicted interactions involving signal transduction and the immune function. Bioinformatics for HDI isocyanurate predicted interactions for cell signaling, structure, and adhesion. We demonstrate that genetic variance impacts the biomarker levels in workers exposed to HDI monomer and HDI isocyanurate, and that HDA and TAHI levels can be used to refine exposure prediction models for both compounds.

**P01.3172. Personal and Area Exposure Assessment at a Stainless Steel Fabrication Facility: Evaluation of Inhalable, Thoracic, Time-Resolved PM<sub>10</sub>, and Lung-Deposited Airborne Metals**

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Abstract: Occupational exposure to multivalent transition metals in welding fume is associated with a variety of adverse health outcomes, including respiratory and cardiovascular impairment, lung cancer, and metal fume fever. Welding fume was designated a Group 1 carcinogen by an International Agency for Research on Cancer (IARC) working group in 2017 and a lack of data on deposition and clearance of welding fume was identified as a gap in the scientific literature. We conducted a detailed exposure assessment of 18 welders (monitoring two work shifts per person) in a stainless steel fabrication facility, evaluating personal exposure to inhalable and lung-deposited PM and airborne metals as well as area thoracic PM and time-resolved PM<sub>10</sub> airborne metals. Urinary metals biomarkers were also measured pre and post shift. Mean area thoracic PM exposure in each of the three shops was 30.1, 214, and 164  $\mu\text{g}/\text{m}^3$ , respectively on the first day of sampling. During all sampled shifts, 14 area PM<sub>10</sub> airborne metals were measured with 15 minute time resolution and concentration time-series were produced for each day. In the largest shop, mean area chromium exposure was 19.5  $\mu\text{g}/\text{m}^3$ , mean area manganese exposure was 32.3  $\mu\text{g}/\text{m}^3$ , and mean nickel exposure was 5.8  $\mu\text{g}/\text{m}^3$  over the measured shift. Lead, tungsten, copper, molybdenum, and vanadium exposure were all highly variable, exhibiting short-duration peaks of varying intensities. Although there is currently no quantitative occupational exposure limit for welding fume, the workers at this facility were exposed to high levels of inhalable PM and metal-specific welding fume components within biologically relevant size fractions.

**P01.3173. Assessing Diesel Particulate Matter Exposure by a Multi-Metric Approach in Three Different Workplaces in Québec, Canada**

Alan da Silveira Fleck

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Abstract: Elemental carbon and total carbon are the surrogates usually used to assess diesel particulate matter (DPM) exposure, but the measurement of different indicators by direct-reading instruments (DRI) is also described and includes advantages and limitations. The aim of this study was to assess and compare several indicators of DPM exposure in three workplaces by using a multi-metric approach. Three workplaces in Quebec (Canada) were evaluated: An underground mine (W1; n=12), a subway tunnel (W2; n=12) and a truck repair workshop (W3; n=12). Ambient particle number concentration (PNC), submicron particulate matter (PM1), and submicron elemental carbon (EC1-DRI) were measured by DRI. Filter-based samples (FBS) were also collected to estimate the respirable and submicron fractions of elemental carbon (ECR and EC1-FBS), as well as the respirable and submicron fractions of total carbon (TCR and TC1). The geometric means of the DRI were: 128,000; 32,800 and 22,700 particles/cm<sup>3</sup> for PNC in W1, W2 and W3, respectively; 165, 20.4 and 6.9 µg/m<sup>3</sup> for PM1; and 148, 25 and 4.1 µg/m<sup>3</sup> for EC1-DRI. W1 also had the highest concentrations of ECR, EC1-FBS, TCR and TC1. EC1-DRI showed the strongest association with EC1-FBS when considering all workplaces ( $\rho = 0.966$ ;  $p < 0.001$ ), but this association decreased at lower concentrations of DPM. PM1 ( $\rho = 0.936$ ;  $p < 0.001$ ) and PNC ( $\rho = 0.871$ ;  $p < 0.001$ ) also showed a strong positive correlation with EC1-FBS. Ratios of 1.05, 1.76 and 1.30 were calculated between TC1/PM1 for W1, W2 and W3, respectively. This study provided solid information about the concentrations, as well as their associations, of several indicators of DPM exposure in three different exposure contexts.

**P01.3174. Use of Geocoding to Understand Variation in Neighborhood Socioeconomic Status in a Nationwide Occupational Cohort across Time, Space and Demographic Characteristics**

Gabriela Bustamante Callejas

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Abstract: Geocoding has been used in environmental epidemiology to understand geographically patterned exposures but has not been widely applied in occupational studies. We present the feasibility of geocoding a nationwide occupational cohort, the US Radiologic Technologists Study (USRT, N=146,021) to: (1) evaluate geocoding across time, (2) test precision of geocoding by rural (vs. urban) status and by neighborhood socioeconomic status (nSES), and (3) explore nSES distribution by some cohort demographic factors. We created a standardized nSES index, based on validated methods, for each census block-group in the US, at 3 time points, using 6 items from the U.S. Census (1990, 2000) and American Community Survey (2010): regionally-adjusted median household income and median housing value, % households with interest/income, % adults who completed high school, % adults who completed college, and % employed persons in managerial occupations. To link nSES to the cohort, we geocoded respondent addresses in 1992, 2003, 2010, to block-group of residence. Over 99% of addresses were geocoded; 76 to 86% were mapped to an address-specific block-group, while the rest were geocoded to a block-group of the zipcode centroid. Urban (vs. rural) addresses and those in the highest (vs. lowest) nSES quintile were more likely to be geocoded to an address-specific block-group (OR=4.6; 95%CI=4.5-4.7 and OR=6.4; 95%CI=6.1-6.7, respectively for 1992 addresses). Results of linear regression show higher nSES in 1990 was associated with USRT participants of female gender ( $\beta=0.22$ ; 95%CI=0.20, 0.23), older age ( $\beta=0.003$ ; 95%CI=0.002, 0.003), white race ( $\beta=0.37$ ; 95%CI=0.35, 0.38) and more recent age-adjusted certification year ( $\beta= -0.018$ ; 95%CI= -0.016, -0.019). Similar results were obtained for other years. This analysis indicates geocoding can describe neighborhood characteristics within the USRT which may be related to diseases linked to occupational exposures like cancer and cardiovascular disease.

Tuesday, August 28

P02. Weather, Climate and Disasters 2

**P02.0010. The 2008 Recession, Human Mortality and Its Changing Relationship with Daily Temperatures in Europe**

Joan Ballester

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**Abstract:** Background. Previous studies have consistently shown the recurrent relationship between macroeconomic cycles and changes in mortality trends during the twentieth century, so that recessions are generally associated with periods of faster life expectancy rise, and periods of economic growth with slower reductions or even increases in mortality trends. These changes have been traditionally associated with a reduction in bad habits, environmental pollution and driving and occupational accidents due to decreased economic activity and employment. Methods and Findings. Here we analyze the link between annual gross domestic product estimations and daily atmospheric temperatures and counts of death for a large ensemble of European regions to describe the effect of the 2008 recession on all-cause human mortality trends. Results show that the regions and countries with the largest (smallest) economic slowdown correspond to those with the largest (smallest) acceleration of the decreasing mortality trend. Our analysis with daily temperature and mortality counts shows that the largest relationship between macroeconomic cycles and mortality trends is observed for the cold half of the year and, to a lower extent, in July and August, while it is smallest for temperatures around the point of minimum mortality. Conclusions. Our study shows the strong interregional association between macroeconomic fluctuations and mortality trends through a continental comparison for the 2008 recession in Europe. Daily climate and mortality data revealed for the first time that this association also depends on the annual cycle of temperatures, and therefore, on the seasonal timing of the underlying causes of death. Results suggest that the relationship between macroeconomic cycles and mortality trends might change as a result of the current context of rising temperatures and an eventual adaptive response of societies.

## **P02.0020. Does Climate Matter? How Temperature and Precipitation Affect the Relationship between Neighbourhood Walkability and Walking for Transportation**

Justin Thielman

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Abstract: Previous research has found associations between neighbourhood walkability and transport walking, which has health benefits. However, the influence of climate on these associations is poorly understood. Our objective is to examine how climate modifies the association between walkability and walking to work or school across Canada. We hypothesize that this association is weaker in areas with more extreme climates. The study population is from the 2007-2014 Canadian Community Health Surveys, ongoing cross-sectional surveys of Canadians aged 12 and up. We excluded people who lived in rural areas or did not work or attend school. These surveys collect self-reported data on socio-demographics and transport walking. Climate data are 1981-2010 climate normals from weather stations across Canada and walkability data are Walk Score® values of respondents' residential locations. We estimated associations between walkability (split into quintiles) and energy expenditure on walking to work/school, adjusting for socio-demographics. To examine how climate modifies this association, we will incorporate the following variables into these models: mean temperature in hottest and coldest months, mean precipitation in wettest and driest months, days per year and degree days over and under specific temperatures. The mean energy expenditure on walking to work/school was 0.26 kcal/kg/day among people in the highest walkability quintile, compared to 0.08 kcal/kg/day in the lowest quintile. After adjusting for socio-demographics, the difference in energy expenditure was 0.17 kcal/kg/day (95% confidence interval [0.15-0.18]). Climate variables will be incorporated into these models, with results forthcoming. On average, people living in more walkable neighbourhoods walk to work or school more than people in less walkable neighbourhoods. Incorporation of climate variables into this analysis will inform whether climate should be considered when evaluating walkability and physical activity.

## **P02.0030. Impacts of High Temperature on Adverse Birth Outcomes in Seoul, Korea: Disparities by Individual- and Community-Level Characteristics**

Jiyoung Son

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**Abstract:** Introduction: Relatively few studies examined the effect of temperature on adverse birth outcomes and effect modifiers of these associations. We investigated associations between heat exposure and adverse birth outcomes and evaluated how individual and community characteristics affect these associations using birth data in Seoul, Korea, 2004-2012. Methods: Logistic regression was applied to estimate the association between heat index during pregnancy, 4 weeks before delivery, and 1 week before delivery and adverse birth outcomes (preterm birth and term low birth weight). Models were adjusted for infant's sex, mother's age, mother's educational level, birth year, birth month, and air pollution level. We investigated effect modification by individual (infant's sex, mother's age and educational level) and community characteristics (gu-level SES and percentage of green areas of residential address). We also evaluated associations by combinations of individual- and community-level SES. Results: An interquartile range increase (5.5°C) in heat index during pregnancy, 4 weeks before delivery, and 1 week before delivery was associated with an odds ratio of 1.033 (95% CI 1.005, 1.061), 1.019 (95% CI 1.010, 1.029), and 1.018 (95% CI 1.009, 1.027) for preterm birth, respectively. We did not find significant associations with term low birth weight. Higher risk of heat on preterm birth was associated with some individual characteristics such as infants with younger or older mother and lower community-level SES. For combinations of individual- and community-level SES, the highest and most significant estimated effect was for infants with low educated mothers living in lower community-level SES. Conclusions: Our findings have implications for the protection of infants from high heat and for future studies evaluating impacts of high temperatures on adverse birth outcomes. Our results help identify which subpopulations and factors are most relevant for disparities in this association.

## **P02.0040. A Systematic Review and Meta-Analysis of the Association between Daily Mean Temperature and Mortality in China**

Qianlai Luo

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**Abstract:** Introduction: We summarized the evidence of the effects of exposure to hot and cold temperatures on mortality in China. We included studies published in Chinese and English. Materials and methods: We conducted a systematic search of peer-reviewed studies published up to the end of 2016 on daily mean temperature and mortality. Studies were drawn from four English databases- PubMed, MEDLINE, SciVerse Scopus, and Web of Science- as well as one Chinese database, China Knowledge Resource Integrated Database (www.cnki.net). The effect estimates of heat/cold were converted to relative risks (RR) associated with 1 degree increase/decrease beyond the heat/cold reference temperatures. For studies that provided lag-specific estimates, we used both the maximum and minimum of RR estimates. Summary effect estimates for all-cause and cause-specific mortalities, as well as RRs stratified by sex, age, and socio-economic status were calculated. We also investigated patterns of adaptation to hot and cold temperatures at different latitudes and at different reference temperatures. Results: We included a total of 34 articles in this systematic review and meta-analysis. For 1 degree temperature decrease/increase beyond reference points, the risk of non-accidental mortality increased by 3% (RR, 1.03; 95% CI [1.03-1.04]) for cold and 2% (RR, 1.02; 95% CI [1.02-1.03]) for heat, respectively. The risk of cause-specific (cardiovascular, respiratory, cerebrovascular) mortalities increased between 3% and 4% for cold and between 3% and 4% for heat. We identified variation in optimal temperature range related to latitude of the residential area, and differences in people's ability to adapt to heat versus cold. Conclusion: We found consistent evidence of the association between temperature and mortality, as well as evidence of patterns in human adaptation. We discussed implications of these findings for China and for future research activities.

## **P02.0050. Patterns of Environmental Displacement in Indonesia**

Michelle Bell

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**Abstract:** Climate change has the potential to impact global migration patterns which can in turn impact public health. Recent research has been conducted linking large-scale population movement to changes in temperature and precipitation. However, few studies have looked at individual-level differences between those who move for environmental reasons, for non-environmental reasons, and those who do not move at all. It is critical that we understand individual and household-level heterogeneity across migrants and non-migrants in order to more fully understand migratory responses to environmental drivers. This project uses Indonesian household survey data from movers and non-movers for environmental and other causes to address two primary objectives: first, to explore differences in demographics and socioeconomic status, and second, to understand characteristics of the moves themselves. We found that environmental migrants tended to be significantly older, less educated, more likely to be married, and more likely to be female than their non-environmental counterparts. This suggests that migration for environmental purposes is generally undertaken as a family, which contrasts with findings from other regions that show increased rates of young, male household members migrating as a means to diversify income after droughts and other environmental stressors. We also found that environmental moves were generally made over shorter distances and were less likely to cross provincial borders than non-environmental moves, supporting previous research that environmental migration tends to be localized. To mitigate the negative effects of climate change, we must better understand how environmental factors are already influencing migratory patterns. This research provides some insight into this issue in Indonesia. Further work is needed to better explore how environmental stressors affect the migration decision making process and to understand how this displacement affects public health.

**P02.0060. Vulnerability to the Cardiovascular Effects of Ambient Heat in Six U.S. Cities: Results from the Multi-Ethnic Study of Atherosclerosis (MESA)**

Carina Gronlund

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**Abstract:** Background: With climate change, temperatures are increasing. Heat-associated health events disproportionately affect certain subpopulations. However, prior research has often lacked information on individual-level health and air conditioning (AC) and neighborhood stressors/protections. Objectives: To assess whether 1) heat (two-day mean temperature above the local 75th percentile), is associated with increased heart rate and decreased blood pressure, controlling for age, time, season, daily ozone and daily particulate matter (PM<sub>2.5</sub>), and 2) associations differ by anti-hypertensive-medication use, renal function, fasting glucose, emotional support, AC ownership and use, normalized difference vegetation index, neighborhood safety and residence-specific oxides-of-nitrogen and PM<sub>2.5</sub> exposure. Methods: Health and behavioral characteristics were obtained repeatedly on participants of the Multi-Ethnic Study of Atherosclerosis in six U.S. sites (2000-2010). These were linked with airport temperature, air quality, and satellite- and survey-derived neighborhood characteristics. We used a fixed-effects design, regressing health outcomes on linear temperature splines with knots at the city-specific 75th percentiles, interaction terms for each characteristic, and adjustment for month-of-year, age, PM<sub>2.5</sub> and ozone. Results: For a 2-degree-Celsius increase in heat, systolic blood pressure (SBP) decreased by 1.1 mmHg (95% CI: -1.6, -0.6) and diastolic blood pressure by 0.3 mmHg (95% CI: -0.6, -0.1). Among individuals not using anti-hypertensive medications, heat-associated decreases in SBP were 2.1 mmHg greater among individuals with central AC vs. without. The remaining modifiers were not significant after multiple-comparisons corrections or in sensitivity analyses. Conclusions: Outdoor heat is associated with decreasing blood pressure, and cardiovascular vulnerability may vary primarily by central AC ownership.

## **P02.0070. Sentinel Practitioners for the Environment and their Role in Connecting up Global Concerns due to Climate Change with Local Actions: How to Spread Awareness and Skills all over the World**

Paolo Lauriola

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Abstract: Climate-change (C-C) health effects are among the most challenging concerns in our future. The health impacts are currently not well assessed through current statistics. In particular, activities by clinicians in relation to environment and health are still rather underdeveloped. We carried out a systematic bibliographic review on Sentinel Physician Networks. These were considered in numerous articles (6691 from 1984 to 2017), but very few dealt with environmental-health (EH) issues (just 14 in the same period). Thus we propose the development of a structured system, aimed at monitoring the effects of environmental issues critical for population health, both by raising awareness and by reporting any situation raising concerns. In fact we believe that Family Doctors (FDs) and Pediatricians (PEDs) could play a crucial role in putting global concerns in connection with local actions. As such three two-day courses were staged in Italy to train 61 FDs/PEDs, and covering the following issues: i) C-C health effects, ii) Statistics and environmental epidemiology, iii) EH bibliographic data-bases, iv) Communication and advocacy, v) Educational methods. A quantitative evaluation was carried out and 100% of trainees agreed to join a systematic training platform to further develop their skills in EH issues. A Sentinel Physicians for the Environment (SPE) Manual is underway. Due to scarcity of experiences across the world, an agreement with the World Health Organization (WHO) Public Health and Environment Dpt. was reached to develop fact sheets to share and disseminate awareness and skills in this field. An international panel of expert has been established. The main aim of this collaboration is the definition of a list of criteria to guarantee sound science, authoritativeness and collaboration at all institutional levels. This proposal in collaboration with WHO could contribute to improving environment and health especially in deprived areas.

## **P02.0080. What can STP Geographies Tell us About the Impact of the Cold Weather Plan for England?**

Peninah Murage

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**Abstract:** Background The Cold Weather Plan (CWP) for England was introduced in 2011 to prevent the adverse health effects of cold weather, however, its impact is currently unknown. This study compares cold risk before and after the CWP implementation, and the distribution in risk at the level of the newly formed STP (Sustainability Transformation Partnerships); this is in recognition of STPs' central role in delivering the NHS transformation agenda. Methods We used daily mean temperatures and mortality count from four years preceding and following CWP implementation (2007-2010 and 2012-2015). Time series regression was used to model cold effect for up to 28 days, and relative risk was estimated for all-cause, disease and age-group specific mortality. Fuel poverty statistics were used to indicate mitigation against cold exposure. Area distribution in risk and fuel poverty were mapped, and STPs with lower than median decline in risk, and higher than average fuel poverty were highlighted. Results Comparing relative risk before and after implementation revealed a significant decline in risk for those aged 0-64 years (RR 1.34, 1.23-1.45, to, 1.09, 1.00-1.19). STP variation in risk was higher in the period following implementation ( $I^2$ , 72.1% vs. 56.2%), additionally, risk increased in a third of STPs; Cornwall and the Isles of Scilly (RR 2.35, 1.72-3.21) and South West London (RR 1.19, 0.97-1.47) had the highest and lowest risk in the more recent period. By combining risk and fuel poverty information, we identified 14 STPs where the need to address cold risk on health remains. Conclusions The national decline in risk in the youngest age group is welcomed and maybe linked to the application of CWP. However, area variations in risk, which increased after 2011, may be attributed to local differences in fuel poverty, and to the implementation of the level 1 (year-round planning) of the CWP.

## **P02.0090. Temperature-Related Mortality in Latin America: A Multi-City Multi-Country Study**

Aurelio Tobias

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**Abstract:** Background Attributable mortality risk for heat and cold has been investigated in Europe and North America. However, none so far has provided estimates for Latin American, with a whole temperature range in different climates. We aimed to estimate the mortality attributable to heat and cold in the Latin American countries participating in the Multi-City Multi-Country Collaborative Research Network, and study their heterogeneity of effects by climatic zones. Methods We collected data for 40 cities in Argentina, Brazil, Chile, Colombia and Mexico, between 1997-2015, totalling over 9 million deaths. We conducted a two-stage approach. Firstly, we estimated city-specific temperature-mortality associations using quasi-Poisson regression with distributed lag non-linear models with 21 days of lag. We calculated attributable deaths for heat and cold above and below the city-specific minimum mortality temperature using cutoffs at the 2.5th and 97.5th temperature percentiles. Next, we combined city-specific estimates using meta-regression including indicator variables for the country and climatic zone. Results More temperature-attributable deaths were caused by cold (4.1%, 95%CI=[3.2 to 5.0%]) than by heat (0.7%, 95%CI=[0.4 to 0.9%]). This was observed consistently in all countries. Larger mortality was attributable to cold in dry and temperate than in tropical climates. While for heat, attributable mortality was larger in dry than in tropical and temperate climates. Discussion Most of the temperature-related mortality burden in Latin American is attributable to the contribution of cold and mainly observed in dry climates. This could be of relevance to developing public-health interventions in the region to minimize the adverse health effects of temperatures. On behalf of the MCC Collaborative Research Network.

## **P02.0100. Temperature and Term Low Birth Weight in California**

Rupa Basu

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Abstract: Few investigations have explored adverse birth outcomes from temperature exposure. In a retrospective cohort study conducted in California from 1999 to 2013, we examined apparent temperature, a combination of temperature and relative humidity, and term low birth weight (LBW) among 43,629 full-term LBW infants and 2,032,601 normal weight infants. Birth certificate data were provided by the California Office of Vital Statistics and meteorologic data came from the California Irrigation Management Information System, US EPA, and National Climatic Data Center. After considering several apparent temperature metrics, we observed the greatest associations between term LBW and exposures over the full gestation (13.0%; 95% confidence interval: 4.1, 22.7% per 10 degrees Fahrenheit (°F) increase in apparent temperature) above 55°F and third trimester exposure above 60°F (15.8%; 5.0, 27.6%). Greater apparent temperature exposure during the first month of pregnancy exhibited no significant risk, while the first trimester had a significantly negative association, and second trimester, last month and last two weeks had slightly increased risks. Mothers who were Black, older, delivered male infants, or gave birth during the warm season conferred highest risks. This study provides further evidence for risks of adverse birth outcomes from high temperatures for pregnant women, particularly for vulnerable subgroups.

## **P02.0110. Associations between Ambient Air Temperature, Low Birth Weight and Small for Gestational Age in Term Newborns in Southern Israel**

Raanan Raz

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**Abstract:** Background: Relatively few studies have examined the association between extreme ambient air temperatures (Ta) and pregnancy outcomes. We investigated the association between Ta, term low birth weight (tLBW) and small for gestational age (SGA) in singleton term infants, using a decade (2004-2013) of regional hospital data in southern Israel. Methods: We linked all births in Soroka University Medical Center in the southern district of Israel and insured by Clalit Health Services with pregnancy Ta, estimated by a hybrid satellite-based spatio-temporally model. Analyses were adjusted for calendar month, year, maternal age, gravidity, parity, ethnicity, sex, poverty index and population density. Results: The study population included 56,141 newborns, with 1,716 (3.1%) cases of tLBW and 8,634 (15.4%) cases of SGA. The average and the median daily Ta across the entire pregnancy were 19.9 (range: 14.6-24.9) degrees centigrade. The lowest Ta quartile was associated with higher risk of tLBW (OR = 1.38, 95%CI 1.16-1.64) while the highest Ta quartile was not significantly associated with tLBW (OR = 1.12, 95%CI 0.96-1.32), in comparison to the two intermediate quartiles. In addition, the lowest Ta quartile was associated with significantly higher risk of SGA (OR = 1.18, 95%CI 1.09-1.28) while the highest quartile was associated with significantly lower risk of SGA (OR = 0.91, 95%CI 0.85-0.99). When examining associations among tLBW, SGA and trimester-specific Ta exposures, we found decreased risk of SGA with high Ta quartile during the 1st trimester (OR = 0.82, 95%CI 0.73-0.92), and increased risk for SGA with low Ta quartile during the 3rd trimester (OR = 1.17, 95%CI 1.05-1.31), while all other associations were not statistically significant. Conclusion: Ta is negatively associated with SGA in singleton term births, with increased risk in low Ta and decreased risk in high Ta.

## **P02.0120. From Prey to Hunter: Training Park Workers to Carry Out Tick Collection as an Alternative Approach for Lyme Disease Vector Surveillance**

Karl Forest Berard

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**Abstract:** CONTEXT Lyme disease (LD) has become a major public health concern in Canada, with flannel-dragging being the gold-standard approach for active tick surveillance. Limited resources hinders proper deployment of this surveillance in Quebec, prompting the exploration of alternatives. A participatory project was therefore developed to explore a new tick sampling scheme based on training of park workers. This training was first implemented in fall 2017 and is also scheduled for spring 2018. **OBJECTIVES** Develop and validate a training targeting park employees to (1) allow them to carry out tick sampling activities autonomously and (2) inform them about LD prevention. **INTERVENTION** Training session was developed using governmental material. It combined a theoretical lecture covering basic concepts of LD and a practical segment in which workers carried out a first tick sampling under trainer's supervision. Subsequently, participants were asked to carry an unsupervised sampling at the same location but on a different day. Ticks collected during samplings were identified and screened for pathogens. Evaluation of the training was done by phone interviews with park managers. **OUTCOME** In fall 2017, 64 workers were trained in 8 parks located in health regions with known LD endemic areas (Monteregie, Mauricie-Centre-du-Quebec, Estrie and Outaouais). All parks were sampled once during the training and half of them managed to carry independent samplings. Overall, 38 LD ticks vector were collected. High appreciation of the training and increased awareness of LD risk among workers were highlighted following evaluation **CONCLUSION** An innovative tick collection method involving workers was explored and will be validated in spring 2018. Such approach could potentially improve active tick surveillance activities while promoting occupational preventive measures. Similar initiatives could be implemented on a larger scale in the future to enhance LD surveillance in Canada.

**P02.0130. Short-Term Prediction of Extremely Hot Days and Heat-Related Mortality Due to Enso and Climate Change**

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Abstract: The trend of extremely hot temperature days in Taiwan has been increasing during the last decade under climate change. In addition, the associations between the El Niño-Southern Oscillation (ENSO) and temperature and precipitation is well-documented. In this study, based on the observed meteorological data from 1951 to 2016, the estimated climate change trend, and the association with lagged Nino3.4 index, we developed a state-space model for prediction of the extremely hot days in summer for the next few years in Taiwan. We then applied the established model to project heat-related attributable mortality (AM) relative to the reference period 2001-2010. The results showed that the prediction model performed well with high precision. The Taipei metropolitan area is expected to have the most impact with the highest AMs in the near future, which warrants further risk assessment and management for heat-related mortality.

## **P02.0160. Associations between Fine Particulate Matter, Extreme Heat Events and Congenital Heart Defects in the National Birth Defects Prevention Study**

Jeanette Stingone

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Abstract: Previous research reports associations between ambient air pollution measured during pregnancy and the occurrence of congenital heart defects (CHD) in offspring. The objective of this research was to determine if extreme heat events (EHE) during pregnancy may modify the effect of fine particulate matter (PM<sub>2.5</sub>) on CHD occurrence. The study population consisted of 4074 controls and 2632 CHD cases with dates of delivery between 1997 and 2006 that participated in the National Birth Defects Prevention Study, a large, multi-site case-control study. Using the EPA's Air Quality System, daily data from the closest stationary PM<sub>2.5</sub> monitor within 50km from the maternal residential location were averaged across weeks 3-8 post-conception. Using data from the closest weather monitor, the presence of an EHE was defined as maximum ambient temperature in the upper 95th centile for at least two consecutive days. Interaction between PM<sub>2.5</sub> exposure and EHE was assessed using logistic regression models adjusted for maternal age, ethnicity, education and average humidity. Relative excess risks due to interaction were calculated. Using women with low PM<sub>2.5</sub> exposure and no EHE as the referent, there was some evidence of a stronger relationship between high PM<sub>2.5</sub> and ventricular septal defects among women who experienced an EHE (odds ratio, OR 2.14 95% confidence interval, CI 1.19, 3.38) compared to women who did not experience an EHE (OR 0.97 95%CI 0.49, 1.95); however an opposite association between higher PM<sub>2.5</sub> and right ventricular outflow tract obstruction defects was observed among women who also experienced an EHE (OR 0.68 95%CI 0.36, 1.30). Stratified analyses suggest that the relationships between EHE, PM<sub>2.5</sub> and CHD occurrence are stronger among women whose early pregnancies occur during warmer seasons and in warmer climate regions. This study did not provide substantial evidence of interaction between prenatal exposure to EHE and PM<sub>2.5</sub> and CHD occurrence in offspring.

Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency, the Centers for Disease Control and Prevention, the California Department of Public Health, or the Texas Department of State Health Services.

## **P02.0170. The Co-Impacts of Climate Change Policies on Air Quality - Impacts on Health**

Heather Walton

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Abstract: The UK's 2008 Climate Change Act requires an 80% reduction in CO<sub>2</sub>-equivalent emissions by 2050, relative to 1990. Air pollution-associated impacts on health were derived for two policy scenarios (NRPO (nuclear replacement only) and LGHG (low greenhouse gas, with expansion of nuclear power) to meet this reduction, compared with policies in place up to/including the UK 4th carbon budget (the baseline). The energy systems model UK TIMES was linked with air quality model CMAQ-Urban at a 10km rural/2km urban scale to produce annual mean concentrations weighted by ward population (average 6,500 people) for 2011, 2035 and 2050, with linear extrapolation between 2011/2035 and 2035/2050. These concentrations were combined with local authority mortality rates (with birth and mortality improvement projections) and concentration-response functions recommended by the UK Committee on the Medical Effects of Air Pollutants (PM<sub>2.5</sub>, NO<sub>2</sub>) or WHO (ozone). Life years lost were calculated from 2011 to 2154 for Great Britain. Increases in biomass exposures up to 2035 meant that the LGHG and NRPO scenarios resulted in 472,000 and 1,122,000 life years lost from long-term exposure to anthropogenic PM<sub>2.5</sub> compared with the baseline. Reduced NO<sub>2</sub> led to life-years saved (4,892,000 to 7,178,000) rather than lost (range from NRPO, 5 µg/m<sup>3</sup> cut-off to LGHG, 0 µg/m<sup>3</sup> cut-off). However, due to the uncertainty over how much of the effects are due to NO<sub>2</sub> itself rather than other pollutants, the decrease in NO<sub>2</sub> does not eliminate concerns over the PM<sub>2.5</sub> increase from biomass and non-tailpipe emissions. Long-term ozone exposure is projected to decrease but gains are smaller (around 230,000 life years gained) due to the WHO threshold of 35 ppb and the effect on respiratory, not all cause mortality. The opposing trends in NO<sub>2</sub> and PM<sub>2.5</sub> over time may help distinguish pollutant impacts in future epidemiological studies. Careful policy design is needed to optimise greenhouse gas and air pollutant reductions.

## **P02.0180. The Geographic Distribution of Future Ozone-Related Asthma Exacerbation Emergency Department Visits in the Us in a Warming Climate**

Nicholas Nassikas

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**Abstract:** Introduction Asthma affects >24 million children and adults in the United States (US). Daily fluctuations in ground level ozone are associated with higher rates of emergency department (ED) visits for asthma exacerbations. For a given level of anthropogenic emissions of ozone precursors, ozone levels are expected to increase by mid-century due to climate change, with a greater increase under a higher versus a lower climate change scenario. We aimed to quantify the magnitude and spatial distribution of asthma ED visits potentially averted mid-century under a mitigation (RCP4.5) versus a business as usual (RCP8.5) greenhouse gas emissions scenario. Methods We projected daily 8-hr maximum ozone levels across the contiguous US for 2036-2055 under two Representative Concentration Pathways (RCP4.5 and RCP8.5) using a 2040 emissions inventory and regional climate and chemical transport models. We then used BenMAP to estimate mid-century ozone-related asthma ED visits for all ages under each RCP, assuming constant population and no adaptation compared to the present. Results Ozone levels are projected to be an average of 1.3 ppb lower across the US under RCP4.5 versus RCP8.5, with the largest differences projected for the Northern Plains, Midwest, and Northeast. Nationally, 2,809 fewer ozone-related ED visits per year mid-century (out of 91,431 total ozone-related ED visits under RCP8.5) are projected under RCP4.5 versus RCP8.5, all other factors held constant. The largest differences (greatest potential benefits under RCP4.5) in asthma-related ED visits are projected for the Northeast and Midwest regions, including Chicago, New York City, Cleveland, Detroit, and Philadelphia. Conclusions These results suggest that adhering to the lower greenhouse gas emissions described by RCP4.5 would lead to lower daily ozone levels and substantially fewer ED visits for asthma across the US, with potential health benefits considerably larger for some communities and individuals than others.

**P02.0190. High Temperature Associations with Preterm Birth and Mediation by Air Pollutants in Detroit, Michigan, 1991-2001.**

Carina Gronlund

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**Abstract:** Introduction: Preterm births (PTBs) cause significant infant health risks, and several studies have found associations between high temperatures and PTB. To understand this association in Detroit, Michigan and the extent to which temperature effects are mediated by air pollution, we evaluated both the total and natural direct effects (independent of particulate matter, ozone, and nitrogen dioxide) of two-day mean apparent temperature (AT) on PTB for the warm months (May to September), 1991-2001. We evaluated effect modification by maternal age, race, education, smoking status, and prenatal care. Methods: We used a time-stratified case-crossover design with splines of AT and wind speed (National Center for Environmental Information), solar radiation (National Renewable Energy Laboratory), and citywide average precipitation (Oregon State University's Parameter-elevation Regression on Independent Slopes Model) to estimate total effects. To accommodate multiple mediators and exposure-mediator interactions, AT inverse odds weights, predicted by meteorological and air pollutant (Environmental Protection Agency AirData) covariates, were included in a subsequent case-crossover model to estimate direct effects. Results: At 24.9 deg. C (95th percentile of warm-season AT) vs. 18.6 deg. C (50th percentile of warm-season AT), 18.7% (95% CI: 1.3%, 31.4%) of PTBs were attributable to the total effects of AT and 11.1% (95% CI: 3.5%, 17.5%) to direct effects. Relative excess risks of interaction were null for each potential modifier. Conclusion: This additional evidence of a direct association between high temperature and PTB motivates public health interventions to reduce extreme heat exposures among pregnant women.

## **P02.0200. Grassland Phenology and Meteorology Co-Influence Grass Pollen Counts in Victoria, Australia**

Ha Nguyen

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**Abstract:** AIM This study investigated the role of grassland phenology in driving daily and seasonal pollen counts in Melbourne, Victoria and characterized the ecological conditions leading up to Melbourne's epidemic thunderstorm asthma event on 21/11/2016. Landscape ecological conditions have traditionally been overlooked as an environmental driver of pollen variability. An understanding of relationships of pollen counts with vegetation type and phenology is valuable to develop better tools to forecast the pollen season and the associated allergenic risks. **METHOD** We combined 2000-2016 Enhanced Vegetation Index (EVI) data from the Moderate Resolution Imaging Spectroradiometer (MODIS), gridded meteorology products and 1991-2016 grass pollen counts to assess spatial and temporal correspondences among phenology, meteorology and pollen counts in Victoria. Grassland and pollen phenological metrics were analysed for trends and anomalies, and comparisons made of correlations between pollen season metrics and meteorological variables and between pollen season metrics and phenology metrics. **RESULTS** Seasonal grass pollen highly correlated with the integrated EVI while daily grass pollen highly correlated with meteorology. We detected a broad hotspot area northwest of Melbourne which experienced both anomalously high EVI values and a significant delay of peak EVI date in 2016. > 20% of the landscape had not reached peak EVI by the start of the pollen season (05/10/2016), heightening exposure to local flowering and hence pollen emission. **CONCLUSION** We showed that grass phenology directly controls pollen production, including pollen hotspots, whereas meteorology determines where and when high pollen deposition will occur. Future forecasting of pollen season and the associated allergenic risks should take into account the timing and spatial variability of grassland phenology as well as the co-influences over pollen production, transport and deposition between vegetation and meteorology.

## **P02.0210. Relationship between Temperature and Ischemic Heart Disease in Bogotá 2009 - 2014**

Jeimy Corredor Gutiérrez

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**Abstract:** Temperature changes has been associated with a variety of cardiovascular, respiratory and neurological effects. Evidence that accounts for health effects of temperature in tropical countries as Colombia is scarce. Temperature in Bogota has risen from 1 to 2°C since 1997 and the adverse health effects of such changes are uncertain. In this ecological time series analysis study, we explored the temporal patterns of emergency room daily admissions of ischemic heart diseases (IHD) in relation to temperature, relative humidity, ground level ozone and particulate matter (PM10 and PM2.5) from 2009 to 2014 in Bogota. Statistical analysis included Spearman rank correlation, Poisson regression models and distributed lag non-linear models (DNLM). Admissions for angina pectoris increased by 4.1% for each 1°C rise in maximum temperature; admissions for myocardial infarction dropped by 15.7% as average temperature increased in 1°C and decreased by 2.5% for each unit increase in relative humidity. Regarding DNLM models, the relationship between IHD and temperature was stronger and evident at lower (8 and 11°C) and higher temperatures ( $\geq 19^\circ\text{C}$ ); the effects were mostly immediate, particularly with minimum temperature, but there were some delayed effects with maximum temperature which reached a peak in lags 2 and 3 when was adjusted by PM10 and PM2.5. A significant association was also found between the number of events and a wide thermal variation ( $\geq 12^\circ\text{C}$ ) on the same day. This study is the first approach on the patterns of IHD morbidity because of temperature changes in Bogota, a high-altitude low-latitude city. These findings suggest a non-linear exposure response curve between temperature and IHD. Higher temperatures were associated with angina while lower one were to myocardial infarction. Thermal amplitude and effect modification by PM10 and RH were also factors that triggered the number of daily admissions of IHD. Further studies should assess those findings at individual level.

## **P02.0220. The Influence of Weather on the Health and Welfare Conditions of Pigs in the UK: A Time-Series Analysis**

Shakoor Hajat

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Abstract: Given the seasonal nature of some health and welfare conditions in livestock, we explored the extent to which weather factors explain these patterns and whether there are parallels with human health. We obtained the health and welfare data from Food Safety Agency and UK weather data from MET Office. The following conditions were considered: pleurisy, pericarditis, tail biting, TB-like legions and respiratory diseases. Time-series of the daily prevalence of each outcome for the period 2009-2015 were assessed graphically and in relation to daily ambient temperature, adjusting for seasonal patterns, trends and day-of-week effects. The metric considered was daily maximum temperature lagged by up to 28 days. Analyses were conducted at both the national and county-level. The apparent cold effects of the daily maximum temperature on the prevalence of all conditions disappeared after adjustment, particularly for respiratory conditions; there was a 0.6 times decrease in the prevalence of respiratory conditions for every 1°C increase in temperature below 10 °C in the crude model (95%CI 0.57, 0.64). However, in the final model, there was a 1.01 times increase in the prevalence of respiratory conditions for both every 1°C increase in temperature above the lowest value and every 1°C drop below (95%CI 0.86, 1.18; 95%CI 0.88, 1.15 respectively). There was no clear evidence of an association between changes in daily maximum temperature and prevalence of health and welfare conditions. This may be because daily prevalence was not based on the onset of a disease, but rather on the diagnosis of diseases. Although we could not find an association with temperature, other weather factors-rainfall, relative humidity and air frost-may be associated with the prevalence of diseases. Therefore, we will link them with health and welfare data. We are also performing similar investigations using Animal and Plant Health Agency's dataset and the results will be shared.

## **P02.0230. Using Natural Experiments to Evaluate the Potential Public Health Benefits of the Toronto Cold Weather Program**

Tarik Benmarhnia

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**Abstract:** Extreme cold weather alert programs have been implemented in some areas to address the significant health impacts of exposure to cold. One such program is the Toronto Cold Weather Program (TCWP) that was implemented in the City of Toronto since 1996 to protect the public from extreme weather conditions. In this paper, we aim to evaluate the effectiveness of the TCWP in reducing mortality and morbidity outcomes related to cold temperatures. We applied a quasi-experimental study design using the Difference-in-Differences method coupled with propensity-score-matching to determine the effect of the TCWP on daily hospitalizations and deaths due to cardiovascular disease (CVD), coronary heart disease (CHD) or cerebrovascular disease, using two complementary analytical approaches. Overall, the analysis did not detect an impact on reduced mortality/morbidity in the City of Toronto from the TCWP. For example, we obtained a Risk Difference (RD) of -0.88 (per 1,000,000 people) (95% CI: -3.27 to 1.51) and a Risk Ratio (RR) of 0.98 (95% CI: 0.91 to 1.05) people for CVD hospitalizations. The TCWP was not found to be effective in reducing cold related mortality and morbidity which demonstrates the importance of improving existing policies related to cold in Canada and other countries.

## **P02.0240. Diurnal Temperature Range and Mortality in Tabriz (the Northwest of Iran)**

Narges Khanjani

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**Abstract:** Introduction: Recently there has been a lot of interest in global warming and temperature variation's effect on health. This study evaluates the impact of Diurnal Temperature Range (DTR) on mortality in Tabriz, northwest of Iran. Methods: Distributed Lag Non-linear Models combined with a quasi-Poisson regression were used to assess the impact of DTR on cause, age and gender specific mortality, controlled for potential confounders such as long-term trend of daily mortality, day of week effect, holidays, mean temperature, humidity, wind speed and air pollutants. As the effect of DTR may vary between the hot season (from May to October) and cold season (from November to April of the next year), we conducted analyses separately for these two seasons. Results: In high DTR values (all percentiles), the Cumulative Relative Risk (CRR) of Non-Accidental Death, Respiratory Death and Cardiovascular Death increased in the cold season. In all seasons and high DTR value (percentile 90), the CRR (lag 0-6) of respiratory deaths increased as well. Conclusion: Although there was no clear significant effect in low DTR values, high values of DTR increase the risk of mortality in the cold season, in Tabriz, Iran.

## **P02.0250. Climate Change Impact on Heat-Related Mortality - ISI-MIP Context**

Yasushi Honda

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**Abstract:** Background The Inter-Sectoral Impact Model Intercomparison Project (= ISI-MIP) describes itself as "a community-driven climate-impacts modelling initiative aimed at contributing to a quantitative and cross-sectoral synthesis of the differential impacts of climate change." In the project, we compared the difference in number of heat-related deaths among some scenarios including 1.5 degree target. Methods If Representative Concentration Pathway (= RCP) 2.6 is assumed, 1.5 degrees warmer than the preindustrial level would be projected by global circulation models (=GCMs) GFDL-ESM2M, HadGEM2-ES and MIROC5. For these projections, we conducted the future heat-related mortality projections using Shared Socioeconomic Pathways (= SSPs) 1 and 3. As for the calculation of heat-related deaths, we used the model by Honda et al (2014), in which higher risk than minimum mortality temperature (=MMT) at higher than MMT was used. Results Under RCP2.6, SSP1 scenario, number of heat-related deaths in the world estimated with GFDL-ESM2M for 1991-2000 (baseline) and that for 2091-2099 was 143,178 and 381,795. With MIROC5, the numbers were 124,826 and 448,607. At the end of the century, the number of deaths became 2.7 times with GFDL-ESM2M and 3.6 times with MIROC5 compared with the baseline. Under RCP6.0, SSP1 scenario, the corresponding numbers for 2091-2099 were 743,200 with GFDL-ESM2M and 812,612 with MIROC5. Because RCP2.6 and SSP3 cannot coexist, here we report the RCP6.0, SSP3 for 2091-2099. It was 1,248,275 with GFDL-ESM2M, and 1,363,703 with MIROC5. Discussion the heat-related mortality is much more serious in case of SSP3 than in case of SSP1. Under SSP1, the difference between RCP6.0 and RCP2.6 seems also large. The GCM model difference was much smaller than the difference in SSP or RCP. Acknowledgment This study was supported by the Environmental Research and Technology Development Fund (S-14) of the Environmental Restoration and Conservation Agency, Japan.

## **P02.0270. Associations of Temperature Variation and Mortality in 47 Japanese Prefectures**

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**Abstract:** Background / Aim: Few studies have investigated the mortality effects of temperature variation (TV) in Japan. In this study, we employed the newly proposed indicators of inter- and intra-day TVs computed separately using daily mean temperatures above or below the minimum mortality temperature to assess the TV-mortality associations and their relative contribution in comparison to daily mean temperature across Japan. Methods: We collected daily data on temperature and mortality during 1972-2012 from 47 Japanese prefectures. We performed a quasi-Poisson regression analysis incorporating a distributed-lag non-linear model to estimate associations of daily mean temperature, inter- and intra-day TVs with mortality in each prefecture. Results: Most prefectures showed a significant increase in mortality risk associated with daily mean temperature, with relative risks (RRs) reaching 1.236 (95% confidence interval (CI): 1.163, 1.313) for heat in Aomori, and 1.676 (95% CI: 1.313, 2.138) for cold in Wakayama. Inconsistent results for inter- / intra-day TVs were found, except for some protective associations between intra-day TV and mortality in Kochi (RR 0.979; 95% CI: 0.965, 0.993) and Gifu (RR 0.988; 95% CI: 0.98, 0.996) on cold days. Conclusion: We found that the association between mortality and TV was generally small compared with daily mean temperature in Japan. Acknowledgement: this research was supported by the Environmental Research and Technology Development Fund (S-10 & S-14) of the Ministry of the Environment, Japan.

## **P02.0280. Examining the Association between Temperature and Emergency Room Visits from Mental Health-Related Outcomes in California**

Rupa Basu

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**Abstract:** Temperature and morbidity has been explored previously. However, the association between temperature and mental health-related outcomes, including violence and self-harm, remains relatively unexamined. We obtained daily counts of mental health-related emergency room visits involving injuries with external cause from the California Office of Statewide Health Planning and Development from 16 California climate zones from 2005 to 2013, and combined them with data on mean apparent temperature, a combination of temperature and humidity. Using Poisson regression models, we estimated climate zone-level associations, then used random-effects meta-analyses to produce overall estimates. Analyses were stratified by season (warm: May-October; cold: November-April), race/ethnicity, and age. A 10-degree Fahrenheit increase in same-day mean apparent temperature was associated with a 4.8% (95% confidence interval, 3.6-6.0%), 5.8% (4.5-7.1%), and 7.9% (7.3-8.4%) increase in visits for mental health disorders, self-injury/suicide, and intentional injury/homicide, respectively, during the warm season. High temperatures during the cold season were also positively associated with these outcomes. Variations were observed by race/ethnicity, age group, and sex, with Hispanics, Whites, 6-18 year olds, and females at greatest risk for most outcomes. Increasing mean apparent temperature was found to have acute associations with mental health outcomes and intentional injuries, and warrants further studies in other locations.

## **P02.0300. Assessing United States County-Level Exposure for Hurricane and Tropical Storm Epidemiological Research**

Brooke Anderson

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**Abstract:** Hurricanes and other tropical storms bring severe impacts to U.S. communities. These impacts can result from a variety of storm-related hazards, including extreme wind, rain, flooding, and tornadoes. Epidemiological studies vary widely in how they classify exposure to tropical storms, using various hazard-based metrics and, in some cases, using distance from the storm as a surrogate for exposure to storm-related hazards. Here we measure county-level exposure to hurricanes and tropical storms in the United States based on distance from the storm, maximum sustained wind, rainfall, flooding, and tornadoes for all land-falling or near-passing Atlantic basin storms for 1988--2015. We show that the locations identified as storm-exposed varied substantially when switching among these metrics. For example, most wind-based storm exposures were limited to southern counties near the coast, while flood- and rain-based exposures often extended to inland and northern counties. We also show that distance to the storm served as at best a moderate, and often a poor, surrogate in identifying exposure to storm-related wind, rain, floods, or tornadoes. Therefore, when impact studies use distance as a surrogate of exposure to tropical storm exposures or use one hazard-based metric (e.g., wind-based) when the impact is partly or fully caused by a different storm hazard, the analysis will be prone to exposure misclassification, which can mask true associations, even strong associations. To facilitate future research, we make this multi-hazard storm exposure data available through open-source software.

**P02.0310. Trends of Age-Specific Mortality with an Underlying or Contributing Cause Attributed to a Weather-Related Cause of Death in Japan, 1995-2015**

Masao Kanamori

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**Abstract:** Objective: To observe the effect of climate change on the mortality of the elderly and children, we examine age-specific heat-related(HM) and cold-related mortality(CM), and other weather-related mortality during 1995-2015 in Japan. Method: Deaths with an underlying or contributing cause attributed to a weather-related cause of death were included. Heat-related death certificate of ICD-10 codes X30 (exposure to excessive natural heat), T67(heatstroke or sunstroke), cold-related deaths X31(exposure to excessive natural cold), T68(hypothermia), flood-storm-lightning-related deaths. Odds ratios(OR) for weather-related deaths by sex, age group, and period group were obtained using logistic regression. Results and Conclusion: About 93,000 Japanese died from weather-related cause of death (0.41 percent of total death) during 1995-2015. CM tended to have a higher mortality than HM. The tendency was remarkable in male. OR of gender difference between HM and CM is 1.30(1.25-1.35). Based on the mortality at the age group of 40-45 years, the risk of heat-related death increased with aging and increased significantly over aged 80-84(OR 16.9 in X30). CM tended to be similar to HM, and no difference was observed. As a result of analysis in the summer weather in two groups of hot and warm summer, the effect on the mortality of hot weather of elderly people over 80 years old was remarkable as the increase of HM (OR 2.71). There was a tendency that the decrease of CM was lower in the hot summer. For children, HM increased by 2.94 times (aged 10-14, 2003), 2.31 times (aged 15-19, 2011) in the hot summer, but the increase in mortality did not show a certain trend. The differentials in weather-related mortality observed among older people over 80 years old were consistent with previous studies. This study made it possible to better understand the trend of weather-related mortality by observing age-specific mortality. This work was supported by JSPS KAKENHI Grant Number JP17K01829.

## **P02.0320. Impact of Meteorological Parameters on Suicide Rates: A Case-Crossover Study in Southern Germany**

Alexandra Schneider

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**Abstract:** Background. Researchers worldwide reported a seasonal pattern of suicides with peaks in spring and early summer; however, only a limited number of studies has investigated the association of meteorological variables and suicides. Methods. Daily suicides (N=10,595) and meteorological data from 1990 to 2006 were available for four Bavarian cities and ten counties. Immediate, delayed and cumulative effects of air temperature, sunshine duration, cloud cover, relative humidity as well as precipitation on suicide rates were analyzed using a confounder-adjusted time-stratified case-crossover approach. Potential effect modifiers were specific weather conditions, personal or regional characteristics, and season. Results. A 5°C increase in air temperature was associated with a 4.1% (95%-confidence interval: 0.97; 7.4%) and 5.1% (2.0; 8.4%) higher suicide risk on the same day and with a delay of one day, respectively. Further, the suicide risk was 6.2% (0.6; 12.2%) higher on days with low/medium cloud cover (0-6 oktas) compared to days with high cloud cover (7-8 oktas). Temperature effects with a lag of one day were more pronounced in individuals older than 65 years (9.9% (4.3; 15.8%)). While temperature was not associated with suicides in spring we found positive associations in summer, autumn, and winter. The effects of cloud cover were strongest in summer and autumn and on days with air temperature above the median (>8.8°C). The other meteorological variables were not significantly associated with suicide. Discussion. We found a higher risk for suicides in association with short-term increases in air temperature and on days with low to medium cloud cover. This may highlight time periods when people are more likely to commit suicide.

## **P02.0330. Establishing Appropriate Hot Weather Alerting Criteria for British Columbia, Canada**

Kathleen McLean

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**Abstract:** A heat health warning system (HHWS) was developed for the greater Vancouver area of British Columbia (BC), Canada following an unprecedented extreme hot weather event that resulted in a 40% increase in weekly mortality. While the greater Vancouver HHWS has been operational since 2012, there are currently no HHWSs covering the remainder of the province. In collaboration with Environment and Climate Change Canada we established hot weather alerting criteria for four regions with broadly similar climates in BC. We used daily forecasted and observed minimum and maximum air temperatures and daily mortality counts for May through September during 2004 to 2016. For each date (dayt), we selected daytime forecast high temperatures for dayt and dayt+1 and the overnight forecast low temperature falling between dayt and dayt+1 from forecasts made in the afternoon of dayt-2. We tried a range of combinations of minimum and maximum temperature thresholds for each of four climatic areas. For each date, we assigned a hot weather warning category equal to the sum of the total degrees by which the daytime forecast highs fell under the maximum threshold and the overnight forecast low fell under the minimum threshold. We assessed associations between the categories and daily mortality using time-series models. We established the following minimum/maximum hot weather alerting criteria, to be adopted in the summer of 2018: 16°C/29°C in the Southwest; 18°C/35°C in the Southeast; 13°C/28°C in the Northwest; and 14°C/29°C in the Northeast. These values were established by balancing a number of considerations regarding the appropriateness of each threshold, including evidence-based associations with daily mortality and minimization of warning fatigue. These criteria identified the two province-wide extreme hot weather events that affected BC in 2009 and 2015. Hot weather alerting criteria covering all of BC can help public health authorities and citizens prepare for extreme hot weather events.

**P02.0340. Comparison of Two Wet-Bulb Globe Temperature Estimation Methods for Assessment of Heat-Related Mortality: Evidence from 47 Japanese Prefectures**

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**Abstract:** Background / Aim: The wet-bulb globe temperature (WBGT) has been widely used for the heat warning in Japan. However, since the WBGT instruments are not often readily available, it needs to be estimated from the measurements of the common meteorological variables. In this study, we tested the reliability of the WBGT estimation method used by the Australian Bureau of Meteorology (ABM) by comparing it with a proven accurate estimation method by Ono et al. (2014) for evaluating the heat-mortality associations in Japan. Methods: We collected daily data on temperature, humidity, solar radiation, wind speed, water vapor pressure and all-cause mortality from 47 Japanese prefectures during 2006-2012. The meteorological data we used were the daily average ones. The data were restricted to the warm season (May-October). After deriving the WBGT estimates by using each method respectively, a quasi-Poisson model combined with a distributed lag nonlinear model (DLNM) was applied to estimate the WBGT-mortality associations in each prefecture. Results: The correlation coefficient between the two types of WBGT estimates was around 0.95. The estimates of minimum mortality WBGT (MMW) and minimum mortality WBGT percentile (MMWP) by using two WBGT estimates were very inconsistent across prefectures. The correlation coefficient between two sets of MMWs was only 0.3. Conclusions: We found that the WBGT estimates provided by the ABM's method is not accurate enough to express the heat-mortality associations. That may be due to its assumption of the fixed solar radiation and wind speed. Acknowledgement: This research was supported by the Environmental Research and Technology Development Fund (S-10 & S-14) of the Environmental Restoration and Conservation Agency, Japan.

## **P02.0350. The Effect of High Summer Temperatures on Emergency Hospital Admissions in Switzerland: A Comparison to Heat-Related Mortality**

Martina Ragettli

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**Abstract:** Background. While previous studies showed a clear association between high temperatures and mortality in Switzerland, the effect of heat on morbidity is less well understood. To evaluate how hot weather affects morbidity in Switzerland and how it compares to heat-related mortality, we assessed a) cause-specific morbidity during the hot summer 2015, and b) the relationship between heat and emergency hospital admissions (EHA) between 2006 and 2015. Methods. Daily EHA during the summer 2015 (June-August) were analysed in relation to comparison periods. For aim b) daily relationships between day-time maximum (Tmax) temperature and EHA during the warm season (May-September) 2006 to 2015 were assessed for different diagnoses and age groups by applying conditional Poisson regression models combined with Non-Linear Distributed lag models. Results were compared to our similar analyses on heat-related mortality. Results. Overall, we estimated an increase in EHA (non-external causes) by 2.6% (95%CI: 0.2-5.0) during the summer 2015. For the same period, an excess mortality of 5.4% (3.0-7.9%) was estimated. Between 2006 and 2015 an increase in Tmax from the median (22°C) to the 98th percentile (33°C) was associated with an overall 3% increase in EHA over the following four days (relative risk (RR) of 1.03 (95% CI: 1.02-1.05)). Larger increases were observed for respiratory (1.20 (1.09-1.31)) and renal diseases (1.21 (1.04-1.40)) in people aged  $\geq 74$  years, and for infection-related EHA, mainly in children <15 years old (1.24 (1.11-1.37)). In contrast to heat-related mortality, no significant association between Tmax and cardiovascular EHA was found. Conclusions. Our results indicate that increases in ambient temperature during summer months have important impacts on morbidity. In general, the impact was smaller than what was observed for heat-related mortality. Nevertheless, current public health strategies can greatly be improved when targeting measures to both groups of outcomes.

## **P02.0360. Development of Guide Book on Outpatient Treatment and Physical Checkup for Accident Preparedness Substances**

Sunshin Kim

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**Abstract:** INTRODUCTION On September 27, 2012, Hydrogen fluoride leakage accident occurred in Hube Global Co.,Ltd. And such massive chemical accidents involve environmental pollution and severe impact on human bodies. The accidents also may cause large number of victims. Therefore, it is necessary to develop and distribute a guide book on treating outpatient and physical checkup in case of chemical accidents. METHODS For the guide book, certain substances against accidents are selected based on data from Occupational Safety & Health Research Institute and American Center for Disease Control and Prevention, The items correspond to South Korea's status and the related specialists can immediately refer to the guide book on fields or medical institutes in case of chemical accidents. RESULTS The guide book includes information on following items 1) Guide on physical checkup and outpatient treatment for each substances, 2) Guide on first aid, 3) Introductions for physical checkup and outpatient treatment, 4) Substance information sheet for patients, 5) Follow up sheet for patients. CONCLUSIONS This guide book's advantage is that it can be used immediately by related specialist on fields or medical institutes during the chemical accident. In addition, the guide book explains on how to make questionnaire for exposure assessment during the survey on health impact and on how to collect and store biological monitoring sample. Such information will be very useful when dealing with chemical accidents. ACKNOWLEDGEMENT This research was supported by the Environmental Health Center for Hazardous Gas Exposure. REFERENCES Agency for Toxic Substances and disease Registry (ATSDR), 2003. Toxicological profile for Fluorides, Hydrogen Fluoride, and Fluorine (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

## **P02.0370. Finding Health-Based Optimal Thresholds in Extreme Weather Watch Warning Systems**

Pierre Masselot

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Abstract: During the last 15 years, many countries established heat-health watch and warning systems (HHWWS) in order to prevent large amounts of death or hospitalization due to extreme heat. These systems consists in emergency measures launched whenever a heat indicator crosses a predetermined thresholds. Therefore, it is critical to accurately choose the threshold to avoid, either missing important heat events, either triggering too much alerts which would reduce their impact. Because of the usefulness of HHWWS, it is also of interest to extend them to other extreme weather events such as cold spells. However, the methodologies used around the world to set the threshold in the case of heat are highly subjective and do not extend to other weather events or locations. In the present work, we propose objective and data-based methodologies to determine thresholds from a health issue and weather indicators. These methodologies are proposed with the objective of finding a "bump" in the relationship between the health issue and the weather indicators. For this, the machine learning techniques of decision trees and bump hunting are adapted to the case of optimal threshold finding. These methods have the advantage of needing only few subjective decisions from the public health authorities, being efficient with a large number of variables and being flexible enough to be adapted to a large number of variables and locations. Applying them to the common heat-related overmortality case shows that they are able to be more accurate than methods found in the literature to predict overmortality events. These methods are then expected to be useful for improve current thresholds and establish health watch and warning systems for other extreme weather events.

## **P02.0380. Association between Cardiovascular Mortality and Temperature in Mexican Cities**

Julio Cruz

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**Abstract:** Background/Aim Low and high temperatures have been associated with mortality risk. In addition, the temperature-mortality relationship is different across geographic locations and specific causes. The aim of this study was to assess the non-linear and lagged cold and heat effects on cardiovascular mortality in people 65 years old and over from 10 Mexican cities. Methods Average daily temperature and daily counts of mortality were collected from 10 Mexican cities, with more than 1 million inhabitants, from 1998 to 2014. Analyses were carried out through quasi-Poisson regression models with distributed lag non-linear models with 7 days of lag. The association between cold and hot temperatures and mortality was evaluated using cutoffs at 1st and 99th percentiles. The specific estimates were pooled and analyzed by meta-analysis. Models were adjusted for relative humidity, day of the week and holidays. Results Cumulative relative risk (RR) over 7 days (lag 0-7) estimated in conditions of very cold temperatures (under 1st percentile of each metropolitan area) showed the following ranges and pooled effect [RR(95%CI)] for cardiovascular  $RR_{Cav} = 0.89 (0.73, 1.08)$  to  $1.56 (1.19, 2.03)$ ,  $RR_{Pooled} = 1.20 (1.10-1.30)$ ; ischemic heart  $RR_{Isch} = 0.97 (0.75, 1.24)$  to  $3.25 (1.37, 7.72)$ ,  $RR_{Pooled} = 1.32 (1.19-1.48)$ ; cerebrovascular  $RR_{Cev} = 0.67 (0.35, 1.30)$  to  $1.77 (1.27, 2.47)$ ,  $RR_{Pooled} = 1.17 (1.02-1.33)$ . On the other hand, the RR by very hot temperatures (above 99th percentile of each metropolitan area) up to 3 days (lag 0-3) showed the following trend  $RR_{Cav} = 0.70 (0.42, 1.14)$  to  $1.72 (1.33, 2.22)$ ,  $RR_{Pooled} = 1.11 (1.04-1.19)$ ;  $RR_{Isch} = 0.60 (0.33, 1.11)$  to  $1.63 (1.19, 2.24)$ ,  $RR_{Pooled} = 1.12 (1.03-1.23)$ ;  $RR_{Cev} = 0.94 (0.45, 1.97)$  to  $1.36 (0.79, 2.34)$ ,  $RR_{Pooled} = 1.12 (1.08-1.17)$ . Conclusions Our findings suggest that cold and hot temperatures are associated with increased risk mortality for the studied causes in a vulnerable population of 65 years old and over in 10 Mexican cities.

## **P02.0390. Temperature and Fall-Related Hospital Admissions in Hong Kong Sar, China**

Chao Luo

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**Abstract:** Background/Aim Previous studies have found increased fall incidence during winter months. However, most of the studies were conducted among the elderly only. Few studies have directly examined the impact of weather on the occurrence of falls. The findings of these studies are also not consistent. Therefore, this study aimed to explore the influences of temperatures on falls. Methods Between 1998 and 2011, daily falls-related hospital admission were obtained from Hong Kong Hospital Authority, which were compiled with daily meteorological and air pollutants data obtained from the Hong Kong Observatory and Environmental Protection Department, respectively. Generalized Additive Models were used to estimate the effects of daily mean temperature (°C) on daily falls-related hospital admissions while controlling for other meteorological factors, air pollutants, day of the week, seasonality and long-term trends. Lagged effects were also considered. Results A total of 400,737 fall-related hospital admissions were analyzed. The highest falls incidence rate was observed in January, while the lowest in May. A reverse J-shaped association was found. Below a threshold temperature of 28.5°C, daily mean temperature was significantly negatively associated with fall-related hospital admissions. A daily mean temperature of 19.5°C (25th percentile) and 14.5°C (5th percentile) over lags 0-7 were associated with a 11% higher [95% confidence interval (CI): 1.07, 1.15] and 21% higher [95% CI: 1.15, 1.21] falls risks when compared to 28.5°C, respectively. Conclusions A reverse J-shaped association was found between ambient temperature and falls in the general population in a subtropical Asian city. Since falls are predicted to become the 17th leading cause of death by 2030, it is important to better understand the impacts of the changing climate on falls. Preventive plans such as providing proper heating may help decrease the risk of falls associated with low temperatures.

**P02.0400. Short-Term Association between Ambient Temperature and Mental Disorders Hospitalization in an Asian Subtropical City: A Time-Series Study**

Holly Lam

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**Abstract:** Background With the increasing evidence of climate change, human health impact associated with rising global temperature has received more attention. Studies from higher latitudes, with cooler climates, have reported positive temperature-mental disorders association but the association from lower latitudes with warmer climates is still unclear. This study showed the short-term temperature-mental disorders association in a subtropical city located below the Tropic of Cancer with an annual mean temperature over 21°C. Methods Daily mental disorders admissions to public hospitals in Hong Kong during 2002-2011 were regressed on daily mean temperature using distributed lagged nonlinear models with relative humidity, air pollutants, seasonal trend, long term trend, day-of-week and holiday adjusted in the models. Sub-group analyses by disease classes, gender and age-group were conducted. Results A total of 44 600 admissions were included in this study. Temperature was linearly and positively associated with overall mental disorder hospitalizations. The cumulative relative risk of admissions at 28°C vs. 19.4°C (interquartile range, lag 0-2 days) was 1.09 (95% confidence interval 1.03, 1.15). The effect of rising temperature above a threshold of 19°C was the strongest among the elderly > 75 years old. In subgroup analyses by disease classes, episodic mood disorders and transient mental disorders due to conditions classified elsewhere showed strong positive associations with temperature. Conclusions The results of this study agreed with most of those from prior studies that high temperature was associated with a higher risk of mental disorders and the effects were more prominent among older people. The global number of heat-related mental disorder events may grow with the dual effect of global warming and aging population. Health policies should be drafted to address these issues.

## **P02.0420. Estimation of Thermal Comfort Using a WRF-MENEX Model during a Heat Wave in a Complex Urban Area**

Mi-Kyoung Hwang

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Abstract: Thermal comfort could indicate human thermal sensation when exposed to a local meteorological condition. Because humans can suffer illness when exposed to heat or even die, it is essential to assess human comfort levels to increased temperature and to provide this information to the public. This study aims to estimate thermal comfort using the human heat balance model combined with a numerical meteorological model in Seoul mega-city during the heat wave periods experienced during 2016. The gridded thermal comfort index, physiological subjective temperature (PST), was calculated based on the Man-Environment heat Exchange (MENEX) model, which used as inputs the meteorological parameters, clothing insulations, and metabolic rates. High-resolution meteorological parameters were obtained by coupling Weather Research and Forecasting (WRF) with Building Effect Parameterization (BEP)/Building Energy Model (BEM) using detailed urban classification. The modeling results showed that the PST distribution has a clearly heterogeneous spatial distribution during the heat-wave period. The high PST values were largely found in the residential area located in the urban center, due to the high temperature and low wind speed associated with high-density buildings, and the daily maximum PST reached a high temperature of over 44 oC. Our study suggested that the human heat balance model combined with the numerical meteorological model could be used to provide more reliable information about thermal comfort to groups that may be vulnerable to the effects of heat waves in complex urban environments. Acknowledgements. This work was supported by Korea Environment Industry & Technology Institute(KEITI) through the Environmental Health Action Program, funded by Korea Ministry of Environment(MOE)(2017001350003)

## **P02.0430. Cold Temperature and Risk of Death Due to Stroke**

Marianne Bilodeau-Bertrand

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**Abstract:** Objective: Temperature is associated with the risk of death due to myocardial infarction, but the relationship with cerebrovascular events is poorly understood. We evaluated the association between cold temperature and the risk of death due to haemorrhagic or ischemic stroke. Methods: Using data from provincial death registration certificates, we undertook a case-crossover study to investigate the association between cold temperature and death due to stroke during 1981-2013 in Quebec, Canada. We selected deaths between November and April, the coldest months of the year, and paired them to the temperature data. Temperature data were obtained from Environment Canada monitoring stations for each of the 18 health regions in Quebec. We used conditional logistic regression to compute odds ratios (OR) and 95% confidence intervals (CI) for the association between minimum daily temperature and haemorrhagic and ischemic stroke. Models were adjusted for the duration and quantity of snowfall. Results: There were 13,208 deaths due to haemorrhagic stroke, and 16,383 due to ischemic stroke during the study. The risk of death from haemorrhagic stroke was elevated on cold days as well as the following day. Compared with 0°C, a minimum temperature of -30°C was associated with an OR of 1.22 (95% CI 1.08-1.38) for haemorrhagic stroke the day of exposure, and an OR of 1.18 (95% CI 1.04-1.33) the day following exposure. Associations were weaker and not statistically significant for ischemic stroke. Conclusion: Cold temperature was associated with risk of death due to haemorrhagic stroke. In the context of climate change and a greater frequency of extreme winter events, individuals with predisposing risk factors should be aware of the higher risk of death due to haemorrhagic stroke during cold temperature. Environmental alerts targeting populations at risk, including recommendations to minimize exposure during extreme cold, may be merited.

## **P02.0431. The Role of Fulbright Program in Focusing on Canadian and U.S. Environmental Health Issues**

David Goldsmith

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Abstract: Background: Scholars from Canada and U.S. have collaborated with the Fulbright Program to address environmental issues of mutual interest in both countries. Studies of climate change in the arctic and health of Indians/First Nations illustrate the role of Fulbright investigators have had on these issues. Context: Climate change has had drastic impacts on Arctic communities in Alaska and in northern Canadian villages. Researchers from Canada and U.S., spurred on by Fulbright, have brought investigators together to measure the extent of sea level rise and methods to respond to these changes, including rebuilding indigenous communities away from degraded shores. Scholars from U.S. and Canada have also collaborated on means and methods to address environmental degradation, wildlife habitats, and Indian/First Nation health impacts. Examples include indigenous diets, obesity, and diabetes, adolescent suicide, alcoholism, violence towards women, and childhood accidents. Future collaboration: Canada and U.S. share industrial interests in fishing, agriculture, and mining/petroleum extraction, all of which have high rates of workplace accidents, trauma, and death. Additionally, all three industries have very high indigenous participation and concern. Fulbright programs, including active participation from corporate scientists, can be vehicles for developing innovative transnational initiatives to reduce accident injury and death as well as methods for environmental remediation. We need greater professional interest and applications by environmental scientists to Fulbright as well as new environmental health programs directly sponsored by Fulbright to provide a higher profile for future offerings. Conclusion: The Fulbright program has enabled Canadian and American academics and leaders to collaborate across our borders to tackle serious environmental issues. New problems, such as lowering workplace injury rates, need to be added for future scholars to tackle.

## P02. Built Environment, Noise and Greenness 2

### **P02.0440. Environmental Noise Pollution and Risk of Hypertension in Pregnancy**

Marianne Bilodeau-Bertrand

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**Abstract:** Background: A growing number of studies suggest that environmental noise pollution may impact the risk of hypertension, but the relationship during pregnancy is poorly understood. We investigated the association between environmental noise levels and preeclampsia, a hypertensive disorder of pregnancy. Methods: We undertook a retrospective cohort study of 269,263 pregnancies in Montreal, 2000-2013. Using postal codes, we assigned environmental noise pollution levels (dBA) from land use regression models to each pregnancy. We calculated odds ratios (OR) and 95% confidence intervals (CI) for the association of environmental noise with preeclampsia, adjusted for air pollutants, neighbourhood walkability, maternal age, parity, multiple pregnancy, comorbidity, socioeconomic deprivation, and year of delivery. We assessed if associations varied according to preeclampsia severity (mild and severe) and onset time (<34 and ≥34 weeks of gestation). Results: Women exposed to elevated environmental noise levels (≥65 vs. <50 dBA) had a higher prevalence of preeclampsia (37.9 vs. 27.9 per 1,000). Compared with 50 dBA, exposure to a noise level of 65 dBA was associated with 1.09 times the odds of preeclampsia (95% CI 0.99-1.20). Associations were stronger for severe preeclampsia (OR 1.29, 95% CI 1.09-1.54) and preeclampsia before 34 gestational weeks (OR 1.71, 95% CI 1.20-2.43). There was no association with mild preeclampsia and preeclampsia at ≥34 weeks. Conclusion: Environmental noise pollution may be a risk factor for preeclampsia, particularly severe or early onset preeclampsia. In light of rising levels of urban noise, these results suggest that vulnerable populations, including pregnant women, could benefit from residential noise reduction policies.

## **P02.0450. The Impact of Rural Residence on Depression in the Ginkgo Evaluation of Memory Study**

Erin Semmens

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**Abstract:** Introduction: Residence in rural environments has been linked to substantial health disparities including elevated incidence of depression. Risks caused by the rural environment may be due to differences in environmental exposures and their demonstrated impacts on the brain, disparities in access to mental health care, and increased poverty. Geocoding challenges, difficulties in environmental exposure assessment, and small, widely dispersed populations are barriers to doing research in rural areas. Nevertheless, it is critical to include these populations, which have been underrepresented in environmental public health research. Methods: More than 3,000 participants 75 years of age and older residing in four communities in the US were followed between 2000-2008 in the Ginkgo Evaluation of Memory Study (GEMS). Rurality was defined by zip code-level Rural-Urban Commuting Area (RUCA) Version 2 codes. The Centers for Epidemiologic Studies - Depression scale was used to assess depression at baseline and twice a year during follow-up. We evaluated the relationship between RUCA code and depression at baseline using linear regression adjusted for sociodemographic factors and study community. Potential modification of the effect of rurality by study community was also examined. Results: Most GEMS participants resided in "metropolitan" areas. Preliminary analyses indicate no overall impact of RUCA code on depression score but that the impact of a one-unit increase in RUCA code was associated with a small but significantly greater increase (0.56; 95% CI: 0.17, 0.96) in depression score in Washington County, Maryland, relative to Pittsburgh, Pennsylvania. Conclusions: Findings suggest that the effect of rurality on prevalent depression varies by community. Future analyses will examine potential interactions of rural residence and environmental exposures and their impact on change in depression score over time.

**P02.0470. The Health Benefits of Bike Sharing Systems can Outweigh the Risks in China, an Old "Kingdom of Bicycles"**

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**Abstract:** Objectives: This study aimed to quantitatively assess the total health benefits and risks of dockless bike sharing system on mortality rates respectively across China, and finally compare between them. Methods: The information of cycling and registered users between October 2016 to October 2017 in each province/municipality in mainland China was collected using online questionnaire survey and Software Development Kit (SDK) embedded into each bicycle application software. The benefits and risks of modal shift through dockless bike sharing system were respectively assessed for the direct and indirect exposure to air pollution, physical activities, and traffic accidents. Then the overall effects of bike sharing system were estimated by combing all the benefits and risks together. Results: The dockless bike sharing program was rapidly developed between October 2016 and October 2017 across China, with registered users increased from 4.8 million to 156.9 million and total distance of trips increased from 24.7 million km to 1,215.2 million km. As a result of physical activities, 35,842 deaths were avoided across China. 425 deaths were saved due to decreased ambient air pollution exposure which was caused by the decrease in traffic emission. However, 28 more deaths were caused by the direct air pollution exposure due to the increased inhalation during cycling, and 2234 more deaths were resulted in due to the traffic accidents. The combined results showed that a total of 34005 deaths have been saved, with most benefits in Guangdong province, and least benefits in Hainan province. Conclusions: The dockless bike sharing program has been rapidly developed across China, which have led to enormous mortality benefits to health.

## **P02.0480. Urbanization and Prevalence of Hypertension Based on 2017 American Heart Association Guideline for High Blood Pressure in the PURSE-HIS Cohort**

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**Abstract:** **BACKGROUND:** In India, rapid urbanization has had a significant impact on the environment. Little is known about the impact of urban environment on the prevalence of hypertension (HTN). Here we assess the association between HTN and urbanization while controlling for cardiovascular risk factors in the PURSE-HIS cohort, India. **METHODS:** Based on census data, a random sample included 8080 participants (20-76 yrs of age; 56% female) from urban, semi-urban, or rural areas spread over 80 x 80 km. MODIS satellite land cover data at a 1 km x 1 km resolution was joined to participant's geolocated residential position in ArcGIS to assign urban and rural (crops, trees, shrubs and grass land cover) designations. HTN was diagnosed based on an average of 3 brachial blood pressure measures and the 2017 American Heart Association guideline for HTN diagnosis. Multivariable regression models tested the associations between urbanization measures and HTN, adjusting for age, sex, BMI, physical activity, smoking, socioeconomic, stress, anxiety, cholesterol and sodium intake levels and diabetes status. **RESULTS:** Based on census, prevalence in urban, semi-urban and rural communities was 49.3%, 41.3% and 31.6%, respectively. Based on MODIS urban, trees, grass and crops land cover, the prevalence was 46.7%, 39.7%, 37.9% and 35%, respectively. In fully adjusted models, urban participants (OR: 2.11 [1.89, 2.36]) and those residing in urban land cover (OR: 1.53 [1.37, 1.69]) had significantly higher odds for HTN when compared to participants in rural areas and crops land cover, respectively. **CONCLUSIONS:** With close to 50% of the urban population with HTN, there is a significantly higher prevalence of HTN based on the latest (2017) guidelines than previously reported. There is an independent association between urbanization measures and HTN after controlling for cardiovascular risk factors, suggesting unaccounted factors in the urban environment driving the prevalence HTN in urban India.

## **P02.0490. Sociodemographic Patterns of Exposure to Civil Aircraft Noise**

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**Abstract:** Aim: Environmental exposures are often sociodemographically patterned, with greater exposures in communities with lower socioeconomic status (SES) and high racial/ethnic minority populations. Studies have shown an association between civil aviation noise and property values, but little is known about the racial/ethnic and SES exposure patterns. Our aim was to analyze the populations exposed to different noise levels around airports in the New England region of the U.S. to determine if noise exposure disparities were present. Methods: Noise contours, characterized as day-night average sound level (DNL), were developed for major New England airports (n=4) in 2010. U.S. Census blocks and noise contours >45 dB DNL with 1 dB increments were overlaid in a geographic information system; noise exposures were assigned to each census block based on the block centroid. We used t-tests to compare DNL levels between racial/ethnic minority ( $\geq 25\%$  minority population) and non-minority ( $< 25\%$  minority population) blocks, and between blocks with low ( $< 65\%$  of state median) and high ( $> 165\%$  of state median) household incomes. We also compared block noise levels with minority percentage and income using Spearman rank correlation coefficients (rs). Results: DNL for minority and non-minority blocks were the same (mean=49 dB, p-value=0.29), while the difference between low and high income was statistically significant (49 vs. 47 dB, respectively; p-value<0.01). Block average noise levels were not correlated with minority percentage (rs=0.01); lower median income was slightly correlated with increased noise (rs=0.10). Conclusions: Analyses to date suggest that income is more strongly associated with ambient aircraft noise concentrations within the New England region than with race/ethnicity. We will be investigating if these trends are reflected in other regions of the U.S. and determining if there are other population factors that would contribute to noise-related health disparities.

## **P02.0500. Noise Pollution and Preventive Measures**

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Abstract: Noise pollution has an immense impact on the health condition of humans, as it represents a major factor influencing the environment. Moreover, it can badly influence humans' health by affecting the hearing analyzer, the nervous, the digestive, as well as the cardiovascular system. Nowadays, the majority of the population is mainly affected by the transport and aviation noise. The main aim of this research is to evaluate the noise pollution in the City of Sofia, Republic of Bulgaria and to examine the preventive measures regarding it. In that purpose, data from the monitoring system of the Ministry of Health (The Sofia Regional Health Inspectorate) for three-year-period 2015-2017 was used, including 48 spots (locations), divided as follows: 27% residential areas, 2.1% central city areas, 41% areas with very intensive traffic, 25% railways, 2.1% warehouses and 2.1% medical centers and sanatoriums. According to the results, no equivalent noise levels of 78-82 dB(A) have been reported during the recent years. There was only one spot with equivalent level between 73-77 dB(A). In further 11 spots (representing 22.9%) the noise levels ranged between 63-67 dB(A). Further on, the equivalent noise leveled between 58-62 dB(A) in 6 spots (12.5%). At 22 spots (45.8%) the average equivalents were higher. However, for the past three years, a noise reduction of 1-3 dB(A) ranging from 63-67 dB(A) was reported. Through its program for management and reduction of noise pollution, the Municipality of Sofia implements basic measures for prevention and protection of the public health, which encompass: Architecture and urban planning, transport and transport communications, green system and ecology, traffic police, controll, NPO. Despite the measures implemented, the number of spots with average noise levels between 68-72 dB(A) is the highest. To tackle this issue, a more complex approach is needed.

**P02.0510. Association of Exposure to Traffic-Related Air Pollution and Noise with Ischemic Heart Disease in Elderly People Living in Tokyo Metropolitan Area, Japan**

Haruya Sakai

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**Abstract:** Objectives: This cross-sectional study examined the association of exposure to both traffic-related air pollution (TRAP) and noise with ischemic heart disease (IHD) morbidity in elderly people living in the Tokyo metropolitan area. Methods: Six thousand elderly people ( $\geq 65$  years old in April 2014) living in roadside or residential areas of Katsushika ward, Tokyo were randomly recruited. IHD, defined as diagnosis of IHD or history of medication for IHD, was determined by a questionnaire. To assess individual levels of TRAP exposure, annual concentrations of elemental carbon (EC) in 2009 were estimated using a plume dispersion model. For participants living in roadside areas, individual levels of exposure to road traffic noise (Lden) were calculated using distance attenuation formulas. The 24-h noise level was measured at five points in residential areas. A multiple logistic model was used to estimate associations of EC or noise exposure with IHD morbidity, adjusting for potential confounders as well as mutual adjustment for EC and noise exposure. Results: A total of 2,874 participants completed the questionnaire. The estimated mean annual exposure level of EC was  $0.73 \mu\text{g}/\text{m}^3$  (range:  $0.217\text{-}3.29 \mu\text{g}/\text{m}^3$ ). The estimated mean exposure level of noise for participants living in roadside areas was 59.5 dB (range:  $36.2\text{-}82.4$  dB). Noise levels in residential areas were  $< 65$  dB. The adjusted odds ratio (OR) for a  $1 \mu\text{g}/\text{m}^3$  increase in EC was 1.14 (95% confidence interval [CI]:  $0.83\text{-}1.52$ ), and 1.09 (95% CI:  $0.77\text{-}1.49$ ) after additional adjustment for noise. The adjusted OR for higher noise exposure ( $\geq 70$  dB) compared with lower noise exposure ( $< 65$  dB) was 1.26 (95% CI:  $0.72\text{-}2.08$ ), and 1.10. (95% CI:  $0.60\text{-}1.92$ ) after additional adjustment for EC. Conclusions: There are independent effects of TRAP and noise on IHD morbidity among elderly people living in the Tokyo metropolitan area.

## **P02.0520. Physical Activity may Modify the Association between Air Pollution and Brain Structure in the UK Biobank**

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**Abstract:** Air pollution and physical activity have been associated with structural brain outcomes, in opposite directions. Physical activity may modify the relationship between air pollution and health by increasing the rate of particulate deposition in the lungs. Sex may further modify these associations, as men experience higher rates of minute ventilation during physical activity. No studies have reported on these interactions in relation to brain structures. We used the UK Biobank, a prospective, population-based cohort, to examine overall and interaction effects between land use regression-derived measures of air pollution in 2010 (NOX, NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>2.5</sub> absorbance, PM<sub>2.5</sub>-10, PM<sub>10</sub>, accelerometer-measured physical activity from 2013-2015, and sex on MRI measures of brain volumes and white matter hyperintensities in 2014-2015 (n=2,756). We used linear regression and controlled for a variety of covariates. Exposures were scaled to inter-quartile ranges and outcomes were standardized to a mean of 0 and standard deviation of 1. Overall, PM<sub>2.5</sub> absorbance (a measure of black carbon) was associated with more log white matter hyperintensities ( $\beta$  for a 1 IQR increase = 0.04, 95% CI 0.00, 0.09) and vigorous physical activity was associated with less white matter hyperintensities and more grey matter, white matter, and hippocampal volumes. Among men with high levels of vigorous physical activity, but not among women or men with lower levels of physical activity, air pollution was associated with less gray matter volumes (NO<sub>2</sub>  $\beta$ = -0.12, 95% CI -0.22, -0.03; PM<sub>2.5</sub>  $\beta$ = -0.09, 95% CI -0.18, -0.01; PM<sub>2.5</sub> Absorbance  $\beta$ = -0.09, 95% CI -0.17, -0.01; PM<sub>10</sub>  $\beta$  -0.07, 95% CI -0.13, 0.00; 3-way p interactions for reported models <0.05). Although vigorous physical activity is strongly and positively associated with improvements in overall brain structure, such activity may paradoxically exacerbate the inverse association between air pollution and brain structures among men.

**P02.0530. The Primavera Forest and Reduction of Premature Mortality Owing to Cardiovascular Disease in the Metropolitan Area of Guadalajara**

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**Abstract:** Background/Aim Located to the extreme west of the Metropolitan Area of Guadalajara (AMG), the Primavera Forest biosphere reserve is traditionally recognized as an important ecosystem for the city, as winds pass through this forest before entering the city. The purpose of this study is to analyze the effect of the Forest on the health of the city's inhabitants, analyzing rates of premature mortality owing to cardiovascular disease. Method: AMG neighborhoods located less than or more than 10 km from the Primavera Forest were identified. An analysis of variance was conducted for the rates of premature mortality owing to cardiovascular disease in the specified neighborhoods. Mortality data was obtained from the Jalisco Department of Health. Findings: At the geographic level, the neighborhoods with the highest premature death rates (more than 40 premature deaths per 10,000 inhabitants/year) were identified and compared to those neighborhoods with the lowest rate of premature mortality (less than 15 premature deaths/10,000 inhabitants/year), resulting in an evident distribution of premature mortality with a positive correlation (the greater the distance from the Primavera Forest, the greater the premature mortality rate). The analysis of variance confirmed significant statistical differences (0.05) of premature mortality from cardiovascular disease rates in neighborhoods less than 10 kilometers from the Forest. Conclusions: The World Health Organization considers that the great majority of deaths related to the environment are due to cardiovascular disease (WHO, 2016). It has been demonstrated that Guadalajara's environmental determinants related to air polluting agents, and temperatures above 36°C affect the cardiovascular system; and that nearby forests provide air quality regulation services. The types of cardiovascular diseases with the greatest rates of premature death are ischemic heart disease (I20-I25) in first place and circulatory brain disease (I60-I69) in second.

## **P02.0550. Urban Greenness and Mental Health Disorders**

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**Abstract:** Background Natural elements in urban residential environments have been suggested to affect many aspects of human health. Mental health disorders are major contributors to the global burden of disability. There is currently inadequate evidence for the association between urban greenness and mental health. Methods A random survey was conducted in the greater Helsinki area in 2015/16 to collect information on adult ( $\geq 25$  years) population health, risk factors, and use of green space. Presence of a mental health disorder, depression or anxiety, was based on self-reported medication use. Percent coverage of green spaces, such as parks, forests and fields, within 1 km of residence was estimated using land-use data. Associations between residential greenness and mental health disorders were assessed using binary logistic regression. Models were adjusted for socioeconomic and life-style factors, use of summer cottage, residential blue space, and modelled traffic noise levels. Models will also be adjusted for NO<sub>2</sub>. Results There were 5835 participants with data on all covariates. Residential greenness was not associated with mental health disorders in the main analyses. Other indicators of exposure to green space, i.e. use of green space for recreation and use of summer cottage, were associated with health: e.g. OR for depression was 0.577 (95% CI 0.435-0.765) when comparing those visiting green space 1-2 times a week to non-visitors. However, the association between recreational activities and amount of green space was weak. Among persons with no frequent access to summer cottage, OR for the association between residential greenness and depression was 0.915 (95 % CI: 0.827-1.014) for a 10 % increase in green space coverage. Blue space was not associated with the outcomes. Conclusion We found limited evidence for the association between urban greenness and mental health disorders. In contrast, use of summer cottage was associated with lower prevalence of depression and anxiety.

## **P02.0570. Analysis of Physical Attributes and Occupant Reported Symptoms for 10,000 U.S. Homes**

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**Abstract:** Background People are exposed to the indoor environment of homes for as much as 90% daily. Despite an increase in chronic disease with suspected environmental exposures, few epidemiological studies include the indoor environment of homes. The complexity of houses combined with the complications of individual susceptibility present a formidable obstacle to well-structured research. **Methods** An algorithm was developed to rank houses from 1 to 100 based on verifiable physical attributes and behaviours as reported by occupants in an Internet accessed survey. Questions also included a list of symptom complaints, plus whether occupants felt better when they left the house only to recur upon re-entry. Basic statistical analysis was conducted to identify combinations of attributes plus associations between those attributes and behaviours. **Results** Building on previous analysis from a smaller data set, cascading of the effects of attributes tended to result in lower scores than from singular attributes. Occupant responses to house attributes formed a skewed Bell curve, indicating houses are generally low scoring. Houses with cleanable surfaces, appropriate ventilation, moisture control, and current maintenance, for example, tended to have the fewest complaints. Houses that had difficult to clean surfaces, uncontrolled ventilation, dampness, and poor maintenance tended to have the greatest complaints. Anomalies included those who reported multiple complaints in high scoring houses and those who reported few complaints in low scoring houses. **Conclusion** General attributes of houses are common but individual houses are complex. Individuality of occupant experience is complex with frequent outliers. Patterns of apparent uniformity plus clusters of anomalies have been identified. The database of 10,000 houses continues to increase. Associations are beginning to be revealed, raising provocative and potential research questions, and contributions to, epidemiological investigations.

## **P02.0580. Epidemiological Study on Long-Term Health Effects of Wind Turbine Noise in Japan**

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**Abstract:** We investigated whether long-term exposure to low-frequency noise generated by wind power facilities is a risk factor of sleep disorders. We performed an epidemiological study of living environment and health effects, surveying 9,000 residents ( $\geq 20$  years) living in areas with operational wind power facilities. In addition to basic attributes of the individuals, the survey items consisted of questions related to lifestyle, socioeconomic factors, health status, degree of annoyance towards noise, attitudes towards installation of wind power facilities, and responses to landscape. Sleep disorders were assessed using the Athens Insomnia Scale. To assess environmental noise in residential areas near the wind turbines, low-frequency sound exposure levels were measured at 50 community centers of the town. In some cases, the noise from the wind turbine was heard at locations that were 2,000 m away from the nearest wind power facility. Although below the auditory threshold, ultralow-frequency sound ( $< 20$  Hz) measured 46-72 dB (L<sub>Geq</sub>, WTN.). Moreover, several dominant components ranging from 50 to 250 Hz, exceeding the auditory threshold, were recorded; these appeared to be mechanical noise. The prevalence rate of sleep disorders was significantly higher for residents who reported subjectively hearing noise being (by approximately two-fold) than for those who did not. Moreover, the reported prevalence rate of sleep disorders was significantly higher (by approximately two-fold) in residents living at a distance of  $\leq 1,500$  m from the nearest wind turbine compared to that for residents living at a distance  $\geq 2,000$  m, suggesting an dose-response relationship.

## **P02.0590. A Combined Emission and Receptor-Based Approach to Modelling Environmental Noise in Toronto, Canada**

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**Abstract:** Aim: Environmental noise monitoring and modelling was completed to support a major revision of the Toronto Noise By-Law. The main objectives of this work were to describe and quantify outdoor ambient, urban noise levels and sources, and to identify areas and circumstances in Toronto with noise levels that could be injurious to health. Methods: Multi-criteria analysis and location-allocation modelling was utilized to identify monitoring sites with optimal coverage of differing spatial and population characteristics. Additional 'sites of interest' were identified in collaboration with various stakeholders. In total, 220 locations were monitored for a minimum duration of seven days in the summer in 2016. Observed noise levels were used to validate a road traffic noise emission and propagation model, and to identify a land use regression model that predicted the contribution of other sources to ambient noise levels throughout the city. Results: The equivalent 24-hour sound pressure level average for all sites was 62.9 dBA. This level varied significantly with different types of roads and land uses, and elevated noise levels were observed near sensitive areas such as schools, hospitals and long-term care facilities. The traffic noise emission model demonstrated a high level of covariance with observed noise levels, explaining 58%, 60% and 59% of variability during the daytime, nighttime and 24-hour periods, respectively. Combined with land use regression models to account for remaining noise sources, the hybrid models explained 64% to 71% of total noise variance for different time periods. Conclusions: The study showed that road traffic noise emissions account for most of the spatial variability of total environmental noise in Toronto. The combined approach to predict fine resolution noise exposures with emission and receptor-based models presents an effective alternative to other noise modelling approaches.

## **P02.0620. Urban Green Spaces and Cardiovascular Morbidity**

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**Abstract:** Introduction. The objective of the present study was to explore associations between the distance and use of urban green spaces and the risk of cardiovascular morbidity. Methods. Randomly selected 5112 respondents (2195 men and 2917 women) participated in the study in Kaunas, Lithuania, that included self-reported sociodemographic, traditional cardiovascular risk factors, green space usage data and cardiovascular morbidity at follow-up (364 non-fatal cases of cardiovascular diseases (CVD)). SPSS 20.0 version software was used for statistical analysis. Distributions of the study cohort characteristics were tabulated by the distance from green spaces and by the use of city parks. We obtained estimates of the hazard ratio (HR) and 95% CI for non-fatal CVD using the multivariate Cox proportional hazards regression. Results. The proportion of park users among people in the 1st tertile of the distance to green spaces was significantly higher as compared to that among people from the 2nd and the 3rd tertiles (55.0%, 50.3% and 44.1%, respectively,  $p < 0.01$ ). The risk of non-fatal CVD among park non-users living farther away was statistically significantly increased (HR=1.66; 95% CI 1.01-2.73 after adjustment for a range of other risk factors) compared to park users living nearby in the whole population. A statistically significantly increased risk of non-fatal CVD was observed in women who were not park users and were from the 2nd and 3rd tertiles of the distance to green spaces, compared to the reference (HR=2.78, 95% CI 1.16-6.70), but this trend was not observed in men. Conclusions. An increase of the distance from the living place to green spaces among non park users statistically significantly increased the risk of non-fatal CVD compared to park users living a close distance to green spaces for the whole population and women who were not park users and living farther from green spaces.

## **P02.0630. Effect of Environmental Relationship between Fungal Exposure and Asthma in Children**

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**Abstract:** Background: Asthma is one of the most common chronic diseases and can be affected by environmental factors. It has been reported that exposure to indoor environmental factors can cause infantile asthma during infancy and childhood, but the previous studies are not yet clear. Climate change has recently been shown to increase indoor mold. Exposure to fungi is known to be directly related to the development of aggravation. Methods: This study was conducted from July 20, 2016 to September 30, 2016. The study was conducted on 90 household with children under the age of 7 who attend atopy school. The questionnaire surveyed allergic symptoms, social and demographic characteristics, and environmental characteristics. Environmentally hazardous substances were measured such as temperature, humidity, fine dust, volatile organic compounds, formaldehyde, bacteria, fungus, house dust mite, endotoxin. Results: According to the survey results, 9 patients (10%) were treated with asthma, 6 (6.7%) were asthmatic patients during the past 12 months, and 4 patients (4.4%) were asthmatic patients during the past 12 months. There were statistically significant differences in the direct effect of smokers in the family ( $P=0.0328$ ). High-filter vacuum cleaners collected 0.4222 CFU / m<sup>3</sup> in subjects without asthma, and 0.2222 CFU / m<sup>3</sup> in subjects with asthma. In addition, various results confirmed that asthma exacerbated by mold exposure. Conclusions: The results of this study suggest that exposure to fungal by infants and toddlers may play an important role in the development of asthma. In this study, we investigated the relationship between asthma and fungal concentration.

**P02.0640. Comparison of Heart Rate Variability Measurement Methods in Panels of Older Adults from the Outdoor Physical Activity and Health Study**

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**Abstract:** Background: Between May 2013 and August 2015, participants in 5 separate Outdoor Physical Activity and Health study panels were asked to undergo endothelial function testing (EndoPAT, Itamar Medical) and ambulatory electrocardiogram (Holter) monitoring for heart rate variability (HRV) analysis. In research mode, the EndoPAT system also provides HRV data. Our objective was to compare HRV results from Holter and EndoPAT to determine if the two methods were comparable in a field study. Methods: 221 healthy, current non-smokers, aged 55-84 exercised outdoors daily for 30 minutes over the 10 week study period. Participants underwent weekly Holter monitoring (~5hrs; GE SEER), and EndoPAT testing before and after exercise. 5-minute windows of Holter data were analysed for HRV by trained technicians. Time matched EndoPAT HRV results were also collected. Pearson correlations between log-transformed Holter and Endopat HRV data were calculated, accounting for repeated measurements among participants, for all panels and participants, and by age, panel, body mass index (BMI) and sex. Results: Over the 5 panels, HRV was measured 3748 times using Holter monitors and 3680 times using EndoPATs. Participant characteristics varied between panels: mean age, 63-65 years, percent female, 56-71, and percent normal BMI, 14-46. For the 5 panels combined Holter and Endopat HRV time domain measures were strongly and significantly correlated (0.75 to 0.83,  $p < 0.0001$ ), while Holter and Endopat HRV frequency domain measures were less strongly correlated (0.28 to 0.63,  $p < 0.0001$ ). Correlations were consistent between panels, sexes, and BMI groups. Conclusion: Time domain HRV measures from Holter monitor and EndoPAT were strongly correlated. Where both endothelial function and HRV time domain are outcomes of interest, a single instrument to measure both parameters could reduce cost, analysis time, and participant burden.

## **P02.0650. Assessment of Indoor Microbial Exposures**

Meghan Davis

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Abstract: Indoor microbial exposures, including to colonizing opportunistic skin pathogens such as *Staphylococcus aureus*, can be common in household and school environments and may be linked to both infectious and chronic disease outcomes. We have adapted methods for culture-based and/or culture-independent assessment of *S. aureus*, *Escherichia coli*, and other microbes from indoor surface and dust samples and have applied these methods in a variety of settings, including household and school environments. Children may spend a disproportionately high percentage of their time in household and school environments and are a particularly important population to target since these exposures occur during critical developmental windows. Methods range from electrostatic-cloth-based assessment of microbial contamination of surfaces to quantitative polymerase chain reaction (qPCR) assessment of microbial genes in vacuum dust. The goal of this presentation is to describe these methods, discuss their strengths and limitations, and provide examples of how the methods can be applied to outcomes of methicillin-resistant *S. aureus* (MRSA) skin or soft-tissue infection, environmental enteropathy, and asthma. We will show that exposures to *S. aureus* and MRSA are common in household and school environments. We will link exposure to MRSA on household surfaces with MRSA re-colonization among urban and rural U.S. adults and children who previously cleared MRSA colonization. We will examine *E. coli* exposures in household environments as these relate to outcomes of environmental enteropathy among rural Peruvian children. We will demonstrate a high burden of exposure to *S. aureus* and genes related to staphylococcal enterotoxins in the homes of inner-city children with asthma, and link environmental exposure to asthma outcomes. We will discuss the implications for this work and how the methods may be adapted to assessment of other microbial exposures, including bacterial and fungal communities.

**P02.0660. Relationship between Pollen Allergy (Allergic Rhinitis) and Cryptomeria-Specific Immunoglobulin E during Early Pregnancy: Part of a Nationwide Birth-Cohort Study**

Kazunari Onishi

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**Abstract:** The Japan Environment and Children's Study (JECS) measured serum concentrations of immunoglobulin E (IgE) antibodies against *Cryptomeria japonica* pollen during early pregnancy. *Cryptomeria*-specific IgE concentrations of class 2 or higher in pregnant women were most common (66%) at the Koshin Unit Center, located in a rural part of Central Japan. We investigated the relationship between pollen allergy (allergic rhinitis) and serum concentrations of *Cryptomeria*-specific IgE. Data were obtained from the JECS, in which serum concentrations of *Cryptomeria*-specific IgE in 4,178 subjects residing in Yamanashi Prefecture was measured at the Koshin Unit Center during February 14, 2011, and May 29, 2014. Simultaneously, self-reported information about presence or absence of pollen allergy symptoms was collected via a questionnaire. In the group reporting presence of pollen allergy symptoms, the mean and median serum *Cryptomeria*-specific IgE concentration class (on a scale of 0 to 6) was 3.14 and 3, respectively ( $n = 1852$ ), and the mean and median IgE concentrations were 22.4 and 12.6 UA/mL, respectively ( $n = 1827$ ). In the group reporting the absence of pollen allergy symptoms, the mean and median serum IgE concentration classes were 1.67 and 2, respectively ( $n = 2326$ ), and the mean and median IgE concentrations were 9.48 and 0.84 UA/mL ( $n = 2300$ ). Both the IgE concentration classes and actual IgE concentrations showed significant differences between the groups with and without pollen allergy symptoms ( $P < 0.001$ ). The area under the curve (AUC) for the receiver-operating-characteristic (ROC) curve prepared with IgE concentration as a continuous variable was 0.746, and the AUC was approximately the same, 0.741, even with IgE concentration classified on a scale of 0 to 6. When the optimal cut-off point was taken to be 3 (between 2 and 3), the sensitivity and specificity was 77.1% and 63.9%, respectively.

## **P02.0670. Partitioning the Indoor Microbiome: The Way Forward?**

Hal Levin

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Abstract: Microbial communities found indoors (microbiome) are receiving increased attention, in large part due to high throughput DNA sequencing whose costs have dropped several orders of magnitude in the past decade. Funding supporting indoor microbial ecology surveys has incentivised cataloguing of various indoor microbiomes, particularly those with relatively high public visibility. While extreme weather events resulting in large-scale building damage motivated the public health community to identify indoor conditions associated with negative health effects, most recent research has not been purposed to find exposure relationships to health outcomes. Information on health effects of indoor microbiome exposure is limited from scientific perspectives, except for evidence supporting relationships to a relatively few (indoor) microbial agents and high incident infectious disease: e.g., *Legionella pneumophila*, the cause of Legionnaire's Disease and Pontiac Fever; *Mycobacterium tuberculosis*, the cause of tuberculosis; and, rhinovirus, the cause of the common cold. Norovirus, paramyxovirus, and orthomyxoviruses with epidemics or pandemics of measles, and influenza, including Asian and swine flu as well as the widespread, annual outbreaks of "seasonal flu." Potable water supply remains a significant microbial source, transport and exposure route with serious health consequences. Improving understanding of indoor microbial exposure assessments requires unified approaches for indoor sampling, as well as quantitative interpretation of built environment survey results. Extending the broader impacts of indoor microbial NGS surveys, results will require parallel improvements in monitoring building environmental factors and occupants, as well as well-structured interventions. Better "standardization" of sampling, analyses and QA/QC of NGS applications, and of building and occupant meta-data, can improve interpretive power of the growing collective of indoor microbiome surveys,

## **P02.0680. How Public Transport Strikes Affect the Health of Our Citizens?**

Margarita Triguero-Mas

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**Abstract:** Public transport is seen as a key element to reduce air pollution levels in cities. We want to assess whether public transport strikes are associated with health outcomes (hospitalizations and mortality), and if they are mediated by the increase in air pollution. We compiled Barcelona-city data from government records for the period 2005-June 2016. We fitted quasi-Poisson time series regression models for each health outcome with strike occurrence as the explanatory variable. Models were adjusted for day of the week and holiday period. To account for temporal trends, we included a natural spline of time with 5 degrees of freedom per year. Mediation of the effect of strikes on health outcomes by air pollution was evaluated using the Baron and Kenny approach. During the study period, there were 208 days affected by a strike of the metro, train or bus systems. There was a median of 45 deaths per day, with a third of them being from cardiovascular or respiratory causes. In median, there were 74 cardiovascular or respiratory hospitalizations. During strike days there was between a 2.69% and a 45.96% increase in air pollution concentrations. We only detected increases of respiratory mortality during public transport strikes, which increased by 9% (95% CI: 1%, 18%). Stronger associations were found for metro strikes (reaching 66%). In those days, overall mortality and respiratory hospitalizations were also increased by around 16%. Associations between air pollutants and strikes occurrence were found mainly for nitrogen dioxide and black carbon, and especially during metro strikes. However, associations between strikes and health were unaffected by adjusting for air pollution levels, indicating no mediation. Our findings suggest that the increase in air pollution does not explain the increases in health outcomes. One possible explanation could be that days with strikes of the public transport system may magnify respiratory airways susceptibility due to the increase of stress.

## P02. Exposure Measurement, Modeling and Other Methodological Issues 2

### **P02.0690. Collecting and Repurposing Survey Data to Support Exposure Assessments**

Heidi Hubbard

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Abstract: Exposure science requires consideration of chemical sources and human behaviors causing contact with those sources. Human behavior has become an increasingly important component of exposure assessment for consumer products, such as household cleaners and personal care products, and consumer articles, such as furniture and building materials. Quantifying exposure from these sources requires understanding population distributions of which products people use, how frequently they use them, and how much they use. Understanding these drivers of exposure is complicated because accurately measuring human behavior is complex and the average person uses a large number of consumer products. However, The Frank R. Lautenberg Chemical Safety for the 21st Century Act (reforming the Toxic Substances Control Act) requires prioritizing and regulating over 80,000 chemical substances based on their human health and ecological risk potential. Many of these chemicals are found in consumer products. Because overall risk is a function of exposure and hazard potential, we need new methods to estimate the population distribution of chemical exposure from consumer products. This presentation focuses on various survey methodologies, including both sampling and measurement techniques, for assessing the human behavior component of exposure. These include surveys focused on mail/internet questionnaires or phone/in-person interviews about behavior, with paired measurements of exposure media. Using real-world exposure surveys as case studies, we cover specific measurement methods and sampling methods. The measurement methods, such as event history calendars and time-use diaries, show particular promise for detailed consumer product exposure estimation; the sampling methods are used to select households and the specific people in households to capture exposure distributions across the population. We summarize these best practices for designing, conducting, and analyzing exposure surveys.

## **P02.0700. Data Infrastructure and Gateway for Environmental Health Research**

Rachael Jones

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Abstract: Datasets that provide information about environmental quality are increasingly large and complex, and include both spatial and temporal information. These data require specialized skills to clean, organize, integrate with other environmental quality data and health outcome data, and analyze. The objectives of this study are to: 1) evaluate interest of the environmental health research and practice communities in a data infrastructure that integrates diverse environmental quality data, and that is accessible and analyzable through a user-friendly interactive Web-based gateway; and 2) test a prototype data infrastructure and gateway with potential end-users. Herein we present initial ideas about the data content and design of the data infrastructure and the envisioned functionality of the gateway. Our goal is to stimulate conversation with potential end-users.

## **P02.0710. Waste Impact on Children's Health: The Exposome Paradigm**

Dimosthenis Sarigiannis

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Abstract: Assessment of the health impacts (e.g. cancer, neurodevelopmental disorders and congenital anomalies) related to hazardous waste is a major scientific challenge with multiple societal implications. Most studies on the links between hazardous waste and health do not provide established mechanistic links between environmental exposure and disease burden, prohibiting us from exploring cost-effective waste management options. The exposome concept comes to overhaul the nature vs. nurture paradigm embracing a world of dynamic interactions between environmental exposures, endogenous exposures and genetic expression in humans, with a special focus on early developmental stages that have been proven determining for later life health status. In this context, the exposome paradigm provides a novel tool for holistic hazardous waste management taking into account their adverse effects on children's health. The complexity of assessing the health impact of hazardous waste is compounded by the variety of waste types, roughly categorized as (a) municipal, (b) agricultural, (c) e-waste, (d) hospital and (e) industrial. These various types of waste are associated with a broad range industrial chemicals and heavy metals. All these compounds form a complex mixture of highly variable composition in space and time-- accounting for differences in multimedia environmental transfer, persistence and bioaccumulation among the mixture components--to which children are exposed through multiple pathways and routes. Waste streams and the related contamination of environmental media are not viewed in isolation, but rather as components of the exotype, the vector of exposures an individual is exposed to over time. Waste management practices are thus assessed with regard to their effects on children's health at the individual and community level, taking into account intra-subject variability. The effectiveness of the exposome approach is demonstrated in the case of recycling.

## **P02.0720. Seasonal Variations of Exposure to Agricultural Pesticides in Residents Proximate to Vineyards: Sigxposome Study**

Béatrice Fervers

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**Abstract:** Environmental exposure to pesticides is a major public health concern. Residential proximity to treated farmland has been associated with increased pesticides concentrations in residential dust and urine samples. The project investigates seasonal variations of exposure to agricultural pesticides of residents close to vineyards and of pesticide applicators (Beaujolais area, Auvergne-Rhône-Alpes Region), in a longitudinal study with repeated sampling of house dust, urine, blood and hair. We report pilot data for 19 residents (non-smoking men, aged 18-65). **Methods:** We sampled morning urine and house dust in July and October 2015. House dust: Efficiency and repeatability analyses of analytical methods (GC-MS, LC-MS/MS) allowed to retain 53 out of 62 preselected pesticides for analyses (recovery rate 70 -120%; RSD < 20%; LOQ 20-1000 ng/g dust). Urine samples: To screen presence of pesticides and their metabolites, a database containing 59 pesticides and 519 associated metabolites with their exact monoisotopic mass was set up. After solid phase extraction, the concentrated extracts of urine samples were analyzed in full scan mode by LC-HRMS. **Results:** 40 pesticides were quantified in dust, including 11 compounds of high public health priority. Among compounds with a prevalence >70% for one of the 2 sampling periods, significant seasonal variations in pesticide prevalence (n=10) and concentrations (n=14) was found with average concentrations higher in July than in October. 2 of the 3 pesticides metabolites detected in urine, specific to chlorpyrifos & chlorpyrifos-methyl and tebuconazole (both present in house dust), were confirmed by comparison with authentic standards. **Conclusion:** Our study showed seasonal variations of agricultural pesticides in housedust of residents close to vineyards. Correlation between residential dust and urine contamination and proximity to treated vineyards will be further explored. **Funding:** Auvergne-Rhône-Alpes Region; Métropole de Lyon.

## **P02.0730. Pesticide Residues in Soil, Water, Indoor Home Surface and Children's Hands**

Noppanun Nankongnab

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Abstract: Pesticides are commonly used in Thailand for pest management both on the farm and in the home. This research measured pesticide residues in home and farm soil, drinking water, surface water sources on the farm, indoor home surfaces and the hands of farm children during the rainy and dry seasons in three provinces of Thailand (Nakhornsawan and Phitsanulok provinces where the farms used chemical pesticides and fertilizers and Yasothorn province where the farms were organic). The samples were analyzed for parent pesticides (20 organophosphates, 7 carbamates, 7 pyrethroids, glyphosate, paraquat and 3 triazines including atrazine) using standard AOAC analytical protocols. The results showed that for the organic farms in Yasothorn province, no pesticides were detected in soil, water, indoor surfaces or children's hand wipes during the dry season but fipronil-sulfone were found on children's hands, indoor home surfaces and cypermethrin were found on children's hands during the rainy season. In addition, some organophosphate pesticides were also found in pond water, home soil, farm soil and drinking water due to flooding in some areas of the province. In the chemical use farms of Nakornsawan and Phitsanulok province, the quantity of pesticides found in dry and rainy seasons were not significantly different. However, more types of pesticides were found in the rainy season. Pesticides that were found included paraquat dichloride and chlorpyrifos ethyl in soil farm, paraquat dichloride, chlorpyrifos ethyl and cypermethrin in home soil, atrazine, diazinon, carbofuran and ametryn in pond water, atrazine and profenofos in drinking water. Cypermethrin was also found in indoor home surface and children's hand wipes during both the rainy and dry seasons.

## **P02.0740. Exposure Characterization of a Cyanobacteria Harmful Algal Bloom (CHAB) at Clear Lake, CA: Data Collection Methodology**

Susan Viet

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**Abstract:** Potentially harmful freshwater algal blooms of cyanobacteria (CHAB) are increasingly reported among US surface waters. Clear Lake in Lake County, CA is regularly impacted by CHABs during the spring through fall. As part of the US Environmental Protection Agency (EPA)'s effort to characterize CHAB exposures, air and water samples were collected at a pier adjacent to the shore at a public beach on five consecutive weekends during September-October, 2017. Air samples were collected for eight hours at 4-5 LPM; 20 Button samplers with fiberglass filters were collected in duplicate for endotoxin analysis; 20 closed-face, 25-mm MCE filters were collected in replicate for cyanotoxin analysis. Water samples were collected three times during each sampling day. A bucket was dropped from the pier to collect surface water from the top 10 inches; individual samples for analysis were collected from the bucket sample. Water samples were submitted to laboratories for analysis of endotoxin, phytoplankton, cyanotoxins, phycocyanin and chlorophyll-a. Water characteristics (temperature, pH, turbidity, dissolved oxygen) and weather condition (temperature, humidity, wind direction, wind velocity, rainfall) were recorded immediately following each sample collection period. Observations of human activities were made every hour throughout the sampling period, characterized by type of contact with water (no contact, hands/feet in water, partial submersion, full submersion, in boat, or on watercraft. The number of people engaging in each activity were counted by age group category (infants, toddlers, pre-adolescents, adolescents, adults). Dogs were counted due to recent reports of respiratory illness and death among dogs swimming in a CHAB. Initial results indicate that the sampling protocols allow for quantitation of cyanotoxins and endotoxin, and associated human activity. This abstract does not necessarily reflect EPA policy.

## **P02.0750. Chlorine Tolerance and Inactivation of Citrobacter Species Recovered from Wastewater Treatment Plants**

Mojisola Owoseni

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**Abstract:** The increasing tolerance of some microbial pathogens in wastewater effluents to chlorine at the recommended dosages has threatened water security and public health safety. This study investigated the chlorine tolerance of some Citrobacter species recovered from two wastewater treatment plants in the Eastern Cape Province, South Africa. Effluent samples were collected from the clarifier of two wastewater treatment plants in the Eastern Cape Province, South Africa over a period of three months and were processed for isolation of Citrobacter species using standard methods. Presumptive bacterial isolates were identified by 16S rRNA gene sequencing (n=20) and the Basic Local Alignment Search tools (BLAST) analysis. Bacterial isolates at initial population of 8.3 log were screened at the recommended free chlorine of 0.5 mg/L and the chlorine lethal dose and inactivation kinetics at lethal doses were examined. Data was analysed using analysis of variance (IBM SPSS Statistics 23) and linear regression (Origin Pro 2017). The BLAST results revealed a 99% similarity of bacterial isolates to Citrobacter genus. The test bacteria (n=20) at the recommended chlorine dose of 0.5 mg/L gradually declined from 4 - 5 log with chlorine residuals between 0.12 - 0.46 mg/L after 30 min. Treatment at higher chlorine doses (0.75 - 1.5 mg/L) revealed a significant reduction ( $p < 0.05$ ) in viability of bacterial population and complete inactivation of Citrobacter species at lethal doses of 0.75 and 1.0 mg/L in 30 min. Increase in bacterial inactivation significantly correlated ( $p < 0.5$ ) with increase in contact time and R2 values ranged between 0.73 - 0.92 for the three Citrobacter species. Treatment at 0.5 mg/L dosage showed a poor removal efficiency by chlorine while an increase in chlorine concentration at 0.75 - 1.0 mg/L resulted in higher inactivation of Citrobacter sp. and is hereby proposed as an alternative dose to check bacterial tolerance.

## **P02.0760. Urban Mind: Using Smartphone Technologies to Investigate the Impact of Nature on Mental Wellbeing in Real Time**

Ioannis Bakolis

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**Abstract:** It has been suggested that exposure to natural features within the urban environment can have beneficial effects on mental health. However, most existing evidence comes from studies that used a cross-sectional design and did not consider the interaction with individual characteristics such as age, lifestyle and vulnerability to mental illness. We developed a smartphone-based tool (Urban Mind; [www.urbanmind.info](http://www.urbanmind.info)) to examine how exposure to natural features affects momentary mental wellbeing in real-time and real-world environments and how this depends on individual characteristics. The Urban Mind tool was used to monitor 108 anonymous volunteers who completed a total of 3013 assessments over a one-week period. Longitudinal associations between self-reported environmental characteristics and momentary mental wellbeing were investigated using random intercept linear models. Specific natural features such as being outdoors, seeing trees, hearing birdsong and seeing the sky, had beneficial effects on momentary mental wellbeing (all  $p$  values  $< 0.001$ ). These associations were still evident up to 7.5 hours after a single exposure had taken place, indicating time-lasting benefits. In addition, these associations were stronger in people with higher trait impulsivity - a psychological measure of one's tendency to behave with little forethought or consideration of the consequences, and a predictor of higher risk of developing mental health issues. Our investigation extends existing evidence on the benefit of nature on mental wellbeing, by demonstrating time-lasting effects that interact with an individual's vulnerability to mental health issues. These findings have potential implications both from the perspectives of global mental health and urban planning and design. We are currently trialing the Urban Mind app in clinical populations.

## **P02.0780. Polydimethylsiloxane Wristbands as Tools for Estimating Exposure to Semi-Volatile Organic Compounds**

Joseph Okeme

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**Abstract:** Semi-volatile organic compounds (SVOCs) are ubiquitous in the environment owing to their use in many household products, consequently presenting opportunities for human exposure and a range of potential health effects. We aimed to improve exposure assessment by developing personal passive air samplers (PPAS) as inexpensive and easily used tools. PPAS are expected to better capture an individual's exposure circumstances compared to either stationary active or stationary passive air samplers and are much less burdensome than active personal samplers. Here, we tested commonly available silicone rubber or polydimethylsiloxane (PDMS) wristbands as PPAS for measuring levels of SVOCs in non-industrial indoor environments. Target SVOCs were 6 phthalates, 23 brominated flame retardants (BFRs) and 16 polycyclic aromatic hydrocarbons (PAHs). In total, 14 study participants in Toronto, Utrecht and Hong Kong, chosen as a sample of convenience, wore PDMS wristbands continuously for a week while leading their normal lives. Wristband samples were extracted and analysed for target SVOCs using gas chromatography mass spectrometry. Five phthalates and 7 PAHs had detection frequencies >70%. These compounds are found in both gas and particle phases. BFRs had levels generally < method detection limit (MDL), and PAHs and phthalates had levels ranging from These findings show that PDMS wristbands are convenient to use and promising for providing estimates of an individual's exposure to SVOCs.

**P02.0790. Commuting Exposures to Particulate Air Pollution in Three Canadian Bus Transit Systems: The Urban Transportation Exposure Study**

Keith Van Ryswyk

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**Abstract:** Background: Health Canada's Urban Transportation Exposure study was designed to assess levels of air pollution in Canadian transport environments. As Canadians spend approximately 52 minutes of their day commuting, this environment may contribute a larger proportion of their daily exposure to traffic-related air pollution (TRAP)". Identifying factors related to bus commuting TRAP exposure is key to its mitigation. Methods: From 2010-2013, sampling was conducted using personal monitors in bus transit environments of Toronto, Ottawa, and Vancouver. In each city, data were collected during 3-week sampling campaigns in the summer and winter for fine particulate matter (PM<sub>2.5</sub>), ultrafine particulates (UFPs), and black carbon (BC). Buses were classed as natural gas, electric, hybrid electric/diesel, clean diesel, post 2000 diesel, or pre 2000 diesel. Stations/stops were classed as bus stop, above grade bus station, or below grade / indoor bus station. Particulate air pollution levels were compared between cities, seasons and waiting vs riding. The impact of bus propulsion type and stop/station design on air pollution exposures were evaluated using linear mixed-effect models. Model development included screening for potential confounders such as meteorological factors and land use. Results: Levels of PM<sub>2.5</sub>, UFPs, and BC were similar between cities and with higher UFPs concentrations observed during winter. In Toronto, bus stations had higher (65%, 95%CI: 48-84%) PM<sub>2.5</sub> levels relative to bus stops. Similar differences were seen for BC. Compared to pre-20000 diesels, hybrid electric/diesel buses reduced exposures for PM<sub>2.5</sub>, UFPs, and BC in all three cities. Conclusions: The personal exposure data collected in this study provides a benchmark of Canadian commuter exposure for bus transit and provides evidence of the potential air quality benefits of ventilating indoor/below grade bus stations and replacing older bus models.

## **P02.0800. Air Pollutant Exposure Measured with Low-Cost Sensors: Results from a 50-Node Network in Pittsburgh**

Albert Presto

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**Abstract:** Background: Networks of low-cost air pollutant sensors offer promise for characterizing pollutant concentrations at high spatial and temporal resolution. While numerous studies have described calibration of these sensors and deployments of a few nodes, few studies have evaluated the performance of citywide or other large-scale sensor networks. Methods: We deployed a network of 50 Real-time, Affordable, Multi-Pollutant sensors (RAMPs) for one year in Pittsburgh, PA, USA. The RAMP uses electrochemical sensors to measure CO, O<sub>3</sub>, NO<sub>2</sub>, and either NO or SO<sub>2</sub>; a nephelometer to measure PM<sub>2.5</sub> mass concentrations; and NDIR to measure CO<sub>2</sub>. The RAMPs were deployed in a variety of urban environments representing variations in traffic, industrial, and restaurant source intensities. Results: There is significant spatial variation in all measured pollutants across the RAMP network. Spatial variations manifest across multiple temporal scales. Long-term (annual) differences between nodes are driven by a combination of proximity to sources and nearby land use, whereas industrial and other point sources drive episodic hotspots in daily or hourly concentrations. Comparison of the distributed network to EPA reference monitors enables determination of conditions when the reference monitor does not provide representative concentrations (e.g., daily PM<sub>2.5</sub> within 1 µg m<sup>-3</sup>) over the wider domain covered by the RAMPs. Both median and 95th percentile PM concentrations are higher across parts of the city during periods with southerly winds, compared to westerly winds when regional pollution dominates. The higher concentrations are not seen at the regulatory site, indicating the value of a high density low-cost network for exposure measurements. Conclusions: Distributed networks of low-cost monitors can provide rich spatial and temporal measurements of air pollutant concentrations at a citywide scale.

## **P02.0810. Development of a Novel DNPH Cartridge for Capturing Gaseous Acrolein**

Miyuki Noguchi

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**Abstract:** A DNPH-loaded cartridge has been widely used for capturing gaseous aldehydes such as acrolein. The cartridge is packed with silica gel beads loaded with DNPH, and the aldehydes introduced to the cartridge will be bonded to DNPH to form derivatives. The derivatives are then extracted with a solvent to be analyzed with HPLC. However, acrolein has a double bond, and the derivative with DNPH is subject to be bonded with a DNPH molecule in the vicinity to form the other derivative, a dimer. The dimer is also subject to react with DNPH to form a trimer. The oligomerizations of the DNPH-acrolein derivatives would make the accurate measurement of acrolein in the air difficult, and it is necessary to prevent the oligomerization reactions for the accurate quantification of acrolein. In this study, we developed a new type of the cartridge for capturing and holding gaseous acrolein. The cartridge is packed with DNPH-loaded silica gel beads modified with TEMPO (2,2,6,6-tetra methylpiperidine 1-oxyl) or BHT (dibutyl hydroxytoluene) as oligomerization inhibitors. A known amount of liquid acrolein was injected to the cartridge, and the cartridge was held for a certain period under a controlled temperature condition. Then the acrolein in the cartridge was extracted with acetonitrile, and quantified with HPLC. By the addition of TEMPO, the formation of DNPH-acrolein dimer or trimer was remarkably reduced compared with the case without TEMPO. The prevention of the oligomerization reaction was found to depend on the initial pH of the cartridge: The lower pH is preferable to prevent the oligomerization. The addition of BHT also reduced the formation of oligomers. By using the DNPH cartridge with TEMPO (0.001wt%), about 70% of the acrolein injected to the cartridge was held unchanged for 7 days under 5°C.

## **P02.0820. An Evaluation of a Long-Term Air Sampling Technique Used to Assess Temporal and Spatial Variation to Volatile Organic Compounds from Vapor Intrusion**

Alan Rossner

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**Abstract:** Assessing vapor intrusion (VI) contamination is challenging because of the temporal and spatial variation that can occur within the building envelope. Day-to-day changes in concentration can vary by one or even two orders of magnitude, thus making it difficult to target sample time representative of occupant exposure in occupational and residential settings. The aim of this study was to evaluate the performance of a long-term flow controller (2 weeks) in buildings with VI problems for both seasonal and spatial variabilities. Long-term capillary flow controllers (CFC) connected to evacuated canisters were used to characterize VOCs from VI at four locations with a known history of VI occurrence. The low flow rate CFC provided flow rates ranging from 0.1 to 0.3 mL/min. Evacuated canisters and thermal desorption (TD) tubes were placed side-by-side in four locations inside two large buildings for 14 consecutive days. The sampling events occurred during four seasons in 2017. Six-liter canisters equipped with a diaphragm flow controller were used to collect 24-hour samples for 14 consecutive days, while a set of two canisters equipped with the CFC were used to collect 14-day samples. TD tubes were used to sample for 3, 7, and 14-day intervals. Analysis occurred at Clarkson University using a MARKES CIA Advantage/Unity 2 connected to a GC/MS. To date, four sampling events have been completed resulting in over 500 canister samples assessing the temporal and spatial variability. The results have shown the CFC are within a 95% CI in 15 of the 16 tests ( $p > 0.05$ ). Regression analysis between the CFC and diaphragm flow controllers generated a regression of 0.95. The new canister method captures the advantages of both diaphragm flow controllers and sorbent tubes, without their limitations, by allowing for long-term (>2 weeks) sample collection and characterization of average VOCs in buildings at risk for VI.

**P02.0840. Determination of Personal and Indoor/Outdoor Concentrations of Nicotine for Passive- or Non-Smoker**

Takashi Amagai

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Abstract: Although second-hand smoke is one of the public health problem, few reports quantitatively evaluated the exposure amount of environmental tobacco smoke (ETS) by passive- or non- smoker. This is due to the fact that few analytical methods has been developed that can measure low level and long-term exposure to ETS. Since we selected nicotine as a marker of ETS that contains thousands of chemicals in previous studies, we have developed an analytical method for indoor, outdoor and personal nicotine concentrations. The sampler consisted of collection filter and filter holder. The nicotine was collected on the quartz fiber filter impregnated with sodium hydrogensulfate. The collected filter was extracted by ultrasonication with distilled water, and nicotine was separated and analyzed by LC-MS/MS. The method have high sensitivity and selectivity. Detection limit of nicotine by LC-MS/MS was 2.5 pg, which correspond to 7 ng/m<sup>3</sup> for 24 hour collection using the developed sampler. It prevents re-volatilization and also ensures storage stability by collecting nicotine as a sulfate salt. We have also developed nicotine active sampler using the quartz fiber filter impregnated with sodium hydrogen sulfate. Detection limit of nicotine by the active sampler was 0.05 ng/m<sup>3</sup> for 24 hour collection at a flow rate of 0.1 L/min. The preliminary survey of indoor/outdoor concentrations of nicotine were performed. Nicotine concentrations indoors/outdoors in the six houses where passive- or non- smoker lived in were determined. Outdoor nicotine concentrations were ranged 1.0 to 19 ng/m<sup>3</sup>, and indoor nicotine concentrations were ranged 1.0 to 133 ng/m<sup>3</sup>. Nicotine concentrations of 2 rooms in 6 houses (33 - 133 ng/m<sup>3</sup>) were significantly higher than other rooms (1 - 19 ng/m<sup>3</sup>). This may be due to third-hand smoke in the rooms.

## **P02.0850. A Critical View of Low Cost Sensor System Networks for Air Quality**

Alena Bartonova

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**Abstract:** Low-cost sensor systems (LCSS) represent a disruptive change in air monitoring, and pose numerous challenges. The Citi-Sense project (<http://co.citi-sense.eu>) that operated between 2012 and 2016 in nine European cities, provides a vivid illustration. Three use cases were deployed, on ambient air quality, on indoor environment at schools, and on the quality of urban spaces, with at times, over 300 LCSSs in use simultaneously. We aimed at providing air quality information to stakeholders, but without a clear prior idea of the purpose and DQOs: we felt that information generated by LCSSs can support several objectives. Our knowledge as to what are capabilities of the technology was low and expectations were high. Any large-scale use of LCSS requires to deploy two enabling technologies, sensing technology and information and communication technologies for data transmission, storage and use, and has a number of steps. We have deployed LCSS's from 9 different producers, in a variety of climatic conditions, from Oslo (Norway) to Haifa (Israel), and Edinburg (United Kingdom) to Beograd (Serbia). We thus demonstrate intercomparison issues as well as the dependency of monitoring results on local conditions. Despite extensive field calibration and co-location, we were not able to quantify uncertainty sufficiently to provide comparable data across locations. However, we successfully developed an accurate real-time map, unavailable using other current methods, addressing the interest in real time information. Using LCSSs as personal monitors has similar challenges as traditional methods, and some new ones. User feedback showed that at this stage (2015), only a special interest group can successfully use the devices. We believe there is a great potential to the LCSSs, but also serious obstacles. Quality assurance and quality control of data needs further development. Correct communication of the results and expectation management are a second main barrier to successful use of LCSS.

**P02.0860. Environmental Influences on Health Outcomes-Integrating Real-Time Exposure Measures from Homes into Longitudinal Cohort Studies: Lessons from the Field**

Katherine Sward

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**Abstract:** In North America, adults and children of all ages spend much of their time indoors with the home where a majority of time is passed. Exposure to respirable particulate matter (PM) of varying sizes has been linked to cardiovascular and respiratory problems. Exposures to PM<sub>2.5</sub> contribute to childhood respiratory ailments such as asthma. Utah collaborators with pediatric cohorts aligned with the National Institutes of Health (NIH) ECHO program and NIH PRISMS program conducted pilot projects aimed at using innovative, real-time, low-cost air quality sensors to provide spatio-temporal records of particulate matter (PM) exposures. The projects evaluated participant acceptance, feasibility, and efficacy in building exposure profiles using instrumentation, extant data, models and health information integrated with a single informatics platform. The PM sensors are small and feature secure Wi-Fi and data storage capability. More than 30 participant homes had one outdoor and two indoor sensors capturing time stamped PM counts every minute which were aggregated to daily data for initial analyses. Participants were supportive of using their personal Wi-Fi for sensor data transmission. From the PRISMS project (n=6), mixed modeling showed the daily estimated marginal mean level of small (PM<sub>2.5</sub>) and large (PM<sub>10</sub>) particle counts was lower indoors than outdoors ( $p < 0.001$ ). Among 6 pediatric asthmatic participants reporting daily asthma treatment usage via eAsthma Tracker, indoor PM counts were not related to treatment usage ( $p > 0.05$ ). Higher levels of PM<sub>2.5</sub> outdoors were related to increases in asthma treatment ( $p < 0.001$ ) while outdoor PM<sub>10</sub> were not related to treatment usage ( $p = 0.52$ ) in this small sample. These pilot projects demonstrated the feasibility of gathering environmental exposure data from low-cost sensors at a very fine level of resolution, and ability to integrate and analyze data across disparate data sources using the Utah PRISMS developed infrastructure.

## **P02.0890. Spatial and Temporal Characterization of Chemical Emissions Aboard the AC130 Gunship**

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**Abstract:** Aerial gunships present a unique exposure environment where byproducts from weapons firing are released into the aircraft cabin, potentially exposing the aircrew to hazardous agents. Certain agents, such as carbon monoxide (CO), can have a cognitive effect, which is not only a health concern, but also a concern for operational success. We completed a comprehensive exposure assessment in the cabin and cockpit of two models of the gunship, the AC130J and AC130W. During the assessment, firing exercises were completed using the 105-mm Howitzer and 30-mm GAU/23A Bushmaster II gun both individually and simultaneously. Air sampling for CO, ultrafine particles and metals was conducted near the breathing zone of aerial gunners, weapons systems officers, and pilots and near the regulator intake for oxygen masks in the main cabin to characterize the distribution of contaminants throughout the aircraft. Video monitoring was used to correlate gunner activities with CO levels throughout the aircraft. CO levels in the breathing zone of gunners during firing activities exceeded a 100-ppm action level, but not a 200-ppm exposure limit. CO in the cockpit and near the weapons systems officers was 5-10 times lower than the action level at peak levels. Ultrafine particles reached the cockpit during firing at levels about four times lower than in the breathing zone of the 105-mm Howitzer gunner. Lead was found at detectable levels in the breathing zone of gunners, as well as in the cockpit, but levels did not exceed an action level of 0.025 mg/m<sup>3</sup>. Based on the findings from this study, CO exposure during firing aboard the gunship has the greatest potential to affect the gunners and is not likely a threat to pilots and weapons systems officers. Continuous CO monitoring in the breathing zone of aircrew members would be an effective approach to identify conditions associated with dangerous exposure levels during future missions.

**P02.0900. The Effects of Facemasks on Airway Inflammation and Endothelial Dysfunction in Healthy Young Adults: A Double-Blind, Randomized, Controlled Crossover Study**

Tianjia Guan

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**Abstract:** Background Facemasks are increasingly worn during air pollution episodes in China, but their protective effects are poorly understood. We aimed to evaluate the filtration efficiencies of N95 facemasks and the cardiopulmonary benefits associated with wearing facemasks during episodes of pollution. Results We measured the filtration efficiencies of particles in ambient air of six types of reusable N95 facemasks. The most effective one was used in a double-blind, randomized, controlled crossover study, involving 15 healthy young adults, conducted during 2 days of severe pollution in Beijing, China. Subjects were asked to walk along a busy-traffic road for 2 hours wearing authentic or sham N95 facemasks. Clinical tests were performed four times to determine changes in the levels of biomarkers of airway inflammation, endothelial dysfunction, and oxidative stress within 24 hours after exposure. The facemasks removed 48-75% of ambient air particles between 5.6 and 560 nm in diameter. After exposure, the exhaled nitric oxide level and the levels of interleukin-1 $\alpha$ , interleukin-1 $\beta$ , interleukin-2, interleukin-6, and tumor necrosis factor- $\alpha$  in exhaled breath condensate increased significantly in all subjects; however, the increases in those wearing authentic facemasks were statistically significantly lower than in the sham group. No significant between-group difference was evident in the urinary creatinine-corrected malondialdehyde level, augmentation pressure, or the augmentation index. Compared to the sham group, the ejection duration of subjects wearing authentic facemasks was higher after exposure. Conclusions In young healthy adults, N95 facemasks partially reduced acute particle-associated airway inflammation, but neither systemic oxidative stress nor endothelial dysfunction improved significantly.

## **P02.0910. Developing Field Calibration Models for Non-Reference Monitoring Techniques: A Case Study of Light Scattering Laser Photometers**

John Pearce

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**Abstract:** Non-reference monitoring (NRM) techniques need to be evaluated against reference measurements to ensure appropriate interpretation and application. The aim of this study was to develop a field calibration model for the DustTrak DRX, a NRM light scattering laser photometer that simultaneously measures multiple size fractions of particulate matter (PM), in order to adjust data results based on co-located measurements taken with federal reference (FRM) and equivalent (FEM) methods. We deployed five DRXs at the EPA NCORE site in Columbia, South Carolina, from January 16th through February 7th 2018 to collect co-located data with FRM/FEM PM10 and PM2.5. We evaluate results with descriptive statistics, correlation coefficients, ratios of the overall means (DRX/FEM), overall mean bias, and normalized mean bias. To adjust NRM data, we develop a field calibration model using the framework of a generalized additive model (GAM). During the co-location weather exhibited temperatures ranging from -4.4 to 21.7 °C, humidity ranging from 14 to 100% and wind speed ranging from 0 to 9.3 m/s. PM conditions, although FRM were not presently available, were perceived to be low-to-moderate as the overall average FEM PM2.5 was 6.8 (standard deviation = 5.1) µg/m<sup>3</sup> and the 5-95% range was 2.7 to 12.6 µg/m<sup>3</sup>. Correlations between DRX measurements and hourly FEM PM2.5 measures were strong ( $r = 0.90$  to  $0.91$  and overall mean ratios (DRX/FEM) revealed under reporting of the DRXs (values between 0.64 and 0.71). Mean biases ranged from 1.9 to 2.4 µg/m<sup>3</sup> and normalized mean biases were less than 25% (17.2 - 23.6%). Our GAM performed well as the variability in FEM measured PM2.5 was well explained ( $R^2 = 0.82$ ), the predictive error was relatively low (root-mean-square-error = 2.46), and mean biases of predictions were zero. Our approach allows us to detect and remove NRM instrumental biases and thus improves the comparability and interpretation of data collected using non-reference techniques.

## **P02.0931. Mapping Hotspots of Environmental Burdens in the Framework of Cumulative Risk Assessment in Wallonia**

Julien Caudeville

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**Abstract:** Differential exposure to multiple environmental burdens and benefits across populations with varying vulnerability can contribute heavily to health inequalities. Developing environment and health information systems has therefore become a major focus for public health. In this framework, the Scientific Institute of Public Service (ISSeP) works on building an integrated approach of environmental exposure assessment in the Walloon region, Belgium. This study develops an index-based approach to assess the multiple environmental burdens at regional level and detailed local resolution that can be used in a spatial web tool. Indicators are based on environmental measure of pollutants in ambient air and soil, and on stressors for citizens related to noise and radon. Two methods were combined to identify both zones where pollutions and stressors are cumulating, even below threshold values, and zones where the exceedance of threshold values is frequent. First, a ratio value is calculated for each spatial unit (i.e. statistical sector) by dividing the indicator value by the corresponding threshold values quoted by the WHO or Walloon legal limit values. Other pollution sources (roads, industries, landfills, mine heaps, ...) are estimated by specific GIS processing based on Euclidean distance analysis which vary in relation to pollution effect to population. Secondly, environmental indicators are mapped as proportions of spatial units where the level of potential detrimental environmental factors exceeds the limit values. The spatial tool makes then possible the flexible and weighted combination of the normalized indicators, by computing online the resulting composite indicator. The approach developed in the present study will be compared to other case studies and their aggregation methods by focusing on results and the possible implications on planning interventions by the decision makers.

## P02. Air Pollution 2

### **P02.0940. Short-Term Air Pollution Exposure, Residential Greenspace, Community Deprivation, and Psychiatric Emergency Visits in Children**

Cole Brokamp

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Abstract: Long term exposure to air pollution, residential greenspace, and community deprivation have all been independently associated with anxiety and depression in both children and adults. However, the effect of acute particulate matter less than 2.5 microns in diameter (PM<sub>2.5</sub>) exposures on psychiatric emergency department (ED) visits has not been studied in children. Our objective was to investigate the relationship between community deprivation, residential greenspace, acute PM<sub>2.5</sub>, and the risk for a psychiatric ED visit during childhood. ED visits from Cincinnati Children's Medical Hospital Center (CCHMC) between 2011 and 2015 were extracted from the electronic health record and each patient's geocoded residential address and visit date were used to assess their community deprivation (based on census tract level American Community Survey characteristics), residential greenspace (based on an address level satellite-derived normalized difference vegetation index), and individual-level exposure to daily PM<sub>2.5</sub> (based on a previously validated spatiotemporal model). We used a case control crossover study design stratified on a rolling 28-day period around the case date and day of week. Conditional logistic regression was used to estimate the odds ratio for the risk of a psychiatric ED visit 0 to 3 days after an increase in PM<sub>2.5</sub> while unconfounding for daily temperature, holidays, and within-month temporal trends. During the study period, 13,361 childhood psychiatric ED visits occurred at CCHMC. A 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> caused an increased risk for a psychiatric ED visit one day (OR: 1.07, 95% CI: [1.02, 1.12]) and two days (OR: 1.05, 95% CI: [1.00, 1.10]) later. The effect of PM<sub>2.5</sub> was modified by community deprivation and greenspace ( $p < 0.001$ ), with children living in areas of higher deprivation being more vulnerable to the effects of PM<sub>2.5</sub>. Acute PM<sub>2.5</sub> is a modifiable exposure that causes increased morbidity associated with childhood psychiatric disorders.

## **P02.0950. Oxidative Potential of Fresh and Aged Particles from Food-Cooking Emissions**

Arthur Chan

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Abstract: Particulate matter (PM) emitted from urban areas causes oxidative stress and is associated with adverse health effects. Cooking emissions represent one of the most important sources of organic PM in urban areas and have been shown to contribute 10-34% of total organic aerosol. Despite its importance, the chemical composition of fresh and aged PM from food cooking emissions and its oxidative potential (OP, or ability to cause oxidative stress) are poorly understood. In this work we use cooking oils (peanut oil, canola oil, olive oil) as a surrogate to investigate the chemical composition and its evolution upon simulated atmospheric aging. We determine the composition using thermal desorption-gas chromatography mass spectrometry (TD-GC/MS), and oxidative potential using the dithiothreitol (DTT) assay. Heated cooking oil particles were oxidised in a quartz flow tube reactor in presence of ozone or hydroxyl radicals to simulate atmospheric aging. Quartz filter samples were collected for particle-phase chemical characterization and OP evaluation. Our preliminary results show that the mass normalized OP of aged PM from cooking is similar to that of diesel exhaust particles (traffic emissions) reported in previous literature. We also observed different OPs from various types of cooking oils, among which the OP of canola oil ranks the highest. The unoxidized cooking emissions are found to be mainly comprised of saturated fatty acids ranging from C12-C20, along with palmitoleic acid, oleic acid, linoleic acid and sterols. Aged cooking emissions are comprised of dicarboxylic acids, hydroxy fatty acids, and short chain fatty acids. Overall, using oxidative potential as a screening tool, more toxicological studies are needed to understand the impact of cooking emissions on human health.

## **P02.0960. Long-Term Trends of Air Pollution in Thailand and Effects on Health**

Will Mueller

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**Abstract:** Background: Air pollution is an important preventable cause of illness and disease around the world. Objective: To assess trends in the concentrations of different air pollutants in Thailand across three decades and to make a preliminary assessment of associated health impacts from prolonged exposures. Methods: We collected data from the Thai Pollution Control Department on CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub> from 68 automatic monitoring stations across Thailand, spanning the period from 1996 to 2015. We calculated annual averages of each pollutant and assessed the magnitude and direction of pollutant concentration changes over time. We will combine this historic exposure data with health data, to be provided by the Ministry of Public Health, to conduct a health impact assessment (HIA), based on longer-term exposures, of current disease burdens for select causes of mortality and morbidity. Results: Data were available for each year of the study period from 30 monitoring stations. Reductions in annual mean concentrations were observed for CO (0.88 ppm to 0.70 ppm; -20%), SO<sub>2</sub> (5.4 ppb to 2.4 ppb; -56%), and PM<sub>10</sub> (90.6 µg/m<sup>3</sup> to 44.2 µg/m<sup>3</sup>; -51%). Concentrations remained similar for NO<sub>2</sub> (15.1 ppb to 15.9 ppb; +5%) and increased for both O<sub>3</sub> (14.0 ppb to 21.2 ppb; +51%) and PM<sub>2.5</sub>, though monitoring for the latter only commenced in 2011 (22.5 µg/m<sup>3</sup> to 31.1 µg/m<sup>3</sup>; +38%). Conclusion: Preliminary analysis suggests mixed air quality trends in Thailand in recent decades. Although some improvements are apparent, there is an indication that certain pollutants, i.e., PM<sub>2.5</sub> and O<sub>3</sub>, still may be rising, which will entail adverse health consequences. For further analysis, we will complete a HIA using historic exposure trends, and, taking into account the introduction of air quality policies, we will estimate scenarios of air quality and health in the future.

**P02.0970. The Hematologic Effects Associated with Ambient BTEX Exposure among the Elderly Residents in Nanjing: A Cross-Sectional Study**

Hong Sun

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**Abstract:** Background: Previous studies suggested that occupational low-level and environmental BTEX exposure may have adverse effects on hematologic system, but the evidence is limited and inconsistent. Objective: We evaluated the exposure of indoor BTEX, blood BTEX and their potential effects on hematologic parameters of the residents from one community nearby a petrochemical complex and another in the control area; We also investigated the associations between blood BTEX and hematologic parameters. Methods: The volunteer residents were randomly recruited from one community near petrochemical complex and one community without known petrochemical pollution. Each participant accomplished a questionnaire and donated blood samples to evaluate blood BTEX concentrations and hematologic parameters. Indoor BTEX sampling was performed in 15 households of each community. We compared the data from each community, and utilized GLMs to estimate adjusted associations between blood BTEX concentrations and hematologic parameters. Results: The blood BTEX concentrations and multiple hematologic parameters of the participants were significantly different between the two study groups. The blood BTEX concentrations of the contaminated group were 1.2 to 6.7 times higher than control. Inverse associations were found between ln-transformed blood benzene concentrations and MCHC ( $\beta = -2.75$ ) and platelet counts ( $\beta = -8.18$ ). Several weaker associations were also observed between other compounds and certain hematologic parameters. Conclusions: Our results suggest that exposure to BTEX may have adverse effects on hematologic system including the diminishing concentration of MCHC, platelets, RBC counts and hemoglobin.

## **P02.0980. Association of Childhood Adversity and Increased Inflammatory Reactivity to Traffic Air Pollution**

Hector Olvera Alvarez

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Abstract: Socially disadvantaged individuals are at greater risk for simultaneously being exposed to severe psychosocial stress in childhood as well as poor air quality across the life span. Recent evidence from different bodies of literature suggests that severe early life stress calibrates the immune system as to increase the inflammatory response to air pollution exposure. This synergistic effect between early life stress and air pollution could contribute to disparity in diseases such as cardiovascular disease, diabetes, depression, and certain types of cancer. In this study with healthy young adults, we examined the effect of early life stress on the inflammatory response to acute non-controlled exposure to traffic related air pollution. Participants answered the adverse childhood experiences (ACE) questionnaire prior to exposure, which consisted of watching a nature documentary on television for two hours while seating in a recreational vehicle (RV) parked within 30 ft. from an interstate highway. The air inside the RV had similar air pollutant levels as those immediately outside. Levels of nitric oxide in exhaled breath (eNO) as well as serum levels of interleukin-1 $\beta$  (IL-1 $\beta$ ), interleukin-6 (IL-6), interleukin-8 (IL-8), and tumor necrosis factor alpha (TNF $\alpha$ ) were measured prior to, one hour after, and twenty-four hours after exposure. Change in inflammatory biomarker (eNO, IL-6, TNF $\alpha$ ) levels induced by air pollution as a function of ACE score was examined with "mixed" effects linear regression. Significant positive associations between ACE scores and changes in eNO levels at one-hour post exposure, as well as with IL-1 $\beta$  and IL-6 levels twenty-four hours post exposure were observed. These results were strongly influenced by sex. These results support the hypothesis that early life stress might lead to an increased inflammatory reactivity to traffic related air pollution, which in turn could drive disparity of inflammation-related health problems.

## **P02.0990. Effects of Outdoor NOx on Indoor Levels of NOx**

Rachel Golan

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**Abstract:** Exposure to air pollutants increases morbidity and mortality. Traffic contributes about half of the emitted NOx to the atmosphere. Human activities play a key role in explaining exposure variation. Despite the importance of healthy air in indoor spaces, most studies focus on outdoor air. Misclassification of exposure has been recognized as a limitation of epidemiologic studies. Here we estimated the effect of outdoor traffic related air pollution on indoor air. **Methods:** Simultaneous indoor and outdoor monitoring data of pollutants were recorded during the years 2005-2007 every half hour. We examined variables associated with levels of indoor pollutant NOx( $\mu\text{g}/\text{m}^3$ ). Independent variables included outdoor levels of NOx, meteorological and seasonal factors and human related activities. In multivariate analysis, we used linear regression models and a 'Cosinor' time series technique, to examine predictors for indoor pollutants levels, adjusted for trend and seasonality. We further conducted a multivariable quantile regression analysis, adjusted for the same independent variables as the former model. **Results:** Indoor NOx level differed between weekdays and weekends ( $F=4.25$ ,  $p = 0.015$ ) and between seasons ( $F=14.56$ ,  $p<0.001$ ). Outdoor NOx was the main predictor for indoor NOx levels ( $\beta=0.67$ ,  $p<0.001$ ). In multiple linear regression analysis adjusted for linear trend ( $\beta= 0.134$ ,  $p<0.001$ ), season (winter  $\beta=-1.40$ ,  $p<.001$ , summer  $\beta=0.628$ ,  $p=0.224$ , fall  $\beta=-0.09$ ,  $p=0.83$ , compared to spring), outdoor NOx ( $\beta=-0.81$ ,  $p=.001$ ), temperature ( $\beta=-0.75$ ,  $p=.028$ ) rainfall ( $\beta=-0.50$ ,  $p=.006$ ), relative humidity ( $\beta=0.42$ ,  $p=0.03$ ) wind speed ( $\beta=0.41$ ,  $p=0.01$ ) were associated with indoor NOx levels. **Conclusions:** Our findings contribute to a growing body of literature describing the relationships between indoor and outdoor of traffic related air pollutants. Further understanding the extent of the effect of indoor air on health is essential especially when considering the amount of time people spend indoors.

## **P02.1000. Exposures to Traffic-Related Air Pollutants are Associated with Changes in Amino Acid Metabolism**

Zhanghua Chen

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**Abstract:** Air pollutants (AP) exposures have been associated with increased risk of cardiometabolic diseases; however, the exact mechanism is unclear. In this study, we examined the association between AP exposure and changes in serum metabolite levels using non-targeted metabolomics. A total of 104 participants in southern California (age 18-21 years) were included in this analysis. Of these participants, 56.7% were male, 48.1% were Hispanic White and 39.4% were non-Hispanic White. Ambient air pollutant exposures were collected from central monitors, and traffic-related air pollutants (NO<sub>x</sub>) from freeway/non-freeway sources were estimated by a line dispersion model using home and school addresses. Annual averaged exposure to AP was calculated from monthly concentrations for the year prior to the study visit. Non-targeted, high-resolution metabolomics was analyzed using fasting serum samples. After excluding metabolomics features with >50% missing data, intensities of 13,559 features were detected. After data pre-processing, associations of AP exposures with metabolomic features were examined by linear regression adjusting for age, sex, ethnicity, parental education and body mass index. Significant metabolites were used to create metabolic pathways by pathway enrichment analyses. We found increased exposure to PM<sub>2.5</sub> and non-freeway NO<sub>x</sub> were associated with changes in arginine and proline metabolism ( $p < 0.001$ ) and  $\beta$ -alanine metabolism ( $p = 0.03$ ), suggesting AP-induced oxidative stress. Increased PM<sub>2.5</sub> exposure was also associated with branched-chain amino acids catabolism ( $p = 0.01$ ), which is known to increase diabetes risk. Additionally, increased NO<sub>2</sub> exposure was associated with phenylalanine, tyrosine and tryptophan biosynthesis ( $p < 0.001$ ), indicating activation of stress pathways. In summary, AP exposure, especially from traffic sources, was associated with changes in amino acid metabolism that could further contribute to the development of cardiometabolic diseases.

## **P02.1010. A New Method to Estimate the Health Effect of Mixtures of Ozone, Nitrogen Dioxide, and Fine Particulates in 85 U.S. Counties**

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**Abstract:** Background: Despite substantial improvements in ambient air quality in the past decades, ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>), and fine particulate matter (PM<sub>2.5</sub>) remain as concerns. As these pollutants exist as mixtures in ambient environments, some combinations of these pollutants may be more harmful to human health than other combinations. Identifying harmful pollutant mixtures can help develop multi-pollutant control strategies to better protect health. Current methods exhibit limitations in identifying harmful mixtures. We aim to identify harmful compositions of three-pollutant mixtures in 85 US counties during 1999-2010. Methods: We developed a new method called PANCAKE to quantify O<sub>3</sub>-NO<sub>2</sub>-PM<sub>2.5</sub> mixtures. O<sub>3</sub>-NO<sub>2</sub>-PM<sub>2.5</sub> mixtures are categorized into 27 composition types based on combinations of different O<sub>3</sub>, NO<sub>2</sub>, and PM<sub>2.5</sub> levels. We identified harmful compositions by estimating the effect of each composition of O<sub>3</sub>-NO<sub>2</sub>-PM<sub>2.5</sub> mixture compared to the reference composition on cardiovascular admissions among Medicare patients. Results: We found that a mixture with relatively low levels of some pollutants combined with relatively high levels of other pollutants can be equally or more harmful than a mixture with high levels of all pollutants. Eight out of the 27 composition types, often with NO<sub>2</sub> levels > 17.3 ppb and PM<sub>2.5</sub> levels > 8.8 µg/m<sup>3</sup> combined with any levels of O<sub>3</sub>, were associated with significantly increased cardiovascular admission rates compared to the reference composition. These harmful compositions overall occurred in about 40-50% of days in winter, metropolitan areas, or the East North Central region. Conclusion: Mixture composition plays an important role in determining health risks and may be worth considering when developing air pollution control strategies.

**P02.1020. An LPW Estimate of the Effects of Annual Exposure to PM2.5 and Ozone on Hospital Admission Rates of Medicare Participants in the Southeast U.S.A.**

Joel Schwartz

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**Abstract:** Introduction: Air pollution is associated with hospital admissions, but few studies have examined the long-term effects of PM2.5 and ozone, or at low concentrations. Existing studies do not use causal modeling or account for the competing risk of death. Methods: We fit a marginal structural Cox proportional hazards model, using stabilized inverse probability weights (IPWs) to account for the competing risk of death and confounding. We examined the association between average annual fine particulate matter (PM2.5) and ozone and first hospital admissions of Medicare participants in the southeast US for stroke, chronic obstructive pulmonary disease (COPD), pneumonia, myocardial infarction (MI), lung cancer, and heart failure (HF). Analyses were then restricted to levels below the current U.S. standard: Average annual measurements of PM2.5 below 12 µg/m<sup>3</sup> and zip codes and years in which ozone levels were below 70 parts per billion (ppb) on all days. Results: PM2.5 was significantly associated with an increased hazard of admissions for all studied outcomes; the highest observed being a 6.1% (95% CI: 6.0%- 6.2%) increase in admissions for pneumonia for each µg/m<sup>3</sup> increase in PM2.5. When the analysis was restricted to observations with PM2.5 levels below 12 µg/m<sup>3</sup> we found an increase of 10.2% (95% CI: 9.8%-10.6%). For all causes, the restriction resulted in a higher marginal increase in admissions for that outcome. Ozone was also significantly associated with an increase in the risk of first hospital admissions of all outcomes. The hazard of pneumonia increased by 3.0% (95% CI: 2.9%-3.1%) for each ppb increase in ozone. The estimated effect sizes were well above those reported for short-term exposure. Conclusion: Long-term PM2.5 and ozone exposures are associated with increased rates of hospital admissions for a number of serious illnesses. Our results indicate a need to regulate long-term ozone exposure, and that associations persist below current US PM2.5 standards.

## **P02.1030. Air Pollution and the Modification by Spatial Synoptic Classification on Mortality**

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**Abstract:** Background Korean Peninsula has the distinct seasonal characteristics and the study on seasonality is relatively frequent compared to the relationship with synoptic classification (SSC). In the study, we aimed to investigate the modification effect between air pollution and SSC on mortality. Methods Daily death data were collected through the Korean Statistics between 2000 and 2014 in Seoul, Korea. We conducted the time-series study using Poisson generalized linear models with an allowance of over-dispersion with seven distinctive SSC (Dry moderate [DM], Dry polar [DP], Dry tropical [DT], Moist moderate [MM], Moist polar [MP], Moist tropical [MT], and Transition [T]) and investigated the modification effects between the SSC and PM10 adjusting for other meteorological conditions, and time trend. The estimated effects were expressed as percentage changes in the risk with 95% confidence interval (CI) per interquartile range(IQR) increase in PM10 for daily non-accidental, cardiovascular-, respiratory-related mortality associated with exposure to PM10 at lag 0–4 according to the type of SSC. Results Daily PM10 level was greater in days [DM] (mean, 61.0  $\mu\text{g}/\text{m}^3$ ) and [DT] (mean, 61.8  $\mu\text{g}/\text{m}^3$ ) and the overall risk of mortality increase were observed in non-accidental [1.11% (95% CI 0.50%, 1.73%)], and cardiovascular [1.87% (95% CI 0.68%, 3.08%)] for PM10 IQR increase. In addition, we observed the mortality risk modified by SSC and increased effect was observed in [DM], [DT], [MM], [MT], and [T] in non-accidental and cardiovascular-related mortality. In particular, we observed the increased risk in [MT] regardless cause of death with non-accidental [1.86% (95% CI 1.02%, 2.70%)], cardiovascular [2.01% (95% CI 0.37%, 3.67%)], and respiratory [3.78% (95% CI 0.89%, 6.76%)]. Discussion the application of SSC in the investigation of air pollution and short-term health effects assisted to understand the health risks in overall weather condition.

## **P02.1040. Seasonal Analyses of the Association between Prenatal Ambient Air Pollution Exposure and Abnormal Birth Weight in Guangzhou, China**

Qiong Wang

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**Abstract:** Ambient air pollution has been linked to small for gestational age (SGA). However, the relationship between air pollution and large for gestational age (LGA) is unclear and very few study has investigated seasonal impact on the association between air pollution and SGA/LGA. Using data from the Guangzhou Birth Registry including 506,000 singleton live births between January 2015 and July 2017, we examined associations between ambient air pollutants and risk of SGA/ LGA, and whether the association varied by season. Daily average concentrations of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, and O<sub>3</sub> from 11 monitoring stations were used to estimate district-specific exposures for each participant based on residential addresses during pregnancy. Two-level binary logistic regression models were used to evaluate associations between air pollution and SGA/LGA, controlling for temperature, seasonality, and individual covariates. Stratified analyses by season were performed to assess the modification of season on effects of air pollution. Exposure to PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, and O<sub>3</sub> was associated with increased risk of SGA, especially for exposure during late pregnancy. Stronger effects were observed for NO<sub>2</sub> and O<sub>3</sub>. For an IQR increase in exposure to NO<sub>2</sub> (12.7 µg/m<sup>3</sup>) or O<sub>3</sub> (21.3 µg/m<sup>3</sup>) during the entire pregnancy, SGA risk increased by 8% (OR=1.08, 95% CI: 1.04-1.12) and 13% (OR=1.13, 95% CI: 1.10-1.15), respectively. When examined by season, significant associations between air pollutants and SGA were observed for women who conceived during summer or fall, and the patterns were consistent for all pollutants. Exposure to NO<sub>2</sub> during the entire pregnancy increased the risk of LGA (OR=1.05, 95%CI: 1.03-1.08), however, exposure to other pollutants was associated with reduced risk of LGA. Our results suggest that conception during different season might modify the association between ambient air pollution and SGA. The novel finding that NO<sub>2</sub> exposure increases the risk of LGA warrants further investigation.

## **P02.1050. The Body Response Time in Air Pollution on the Risk of Arrhythmia Symptom Exacerbation**

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**Abstract:** Objectives The body response time and an association between the exposure to air pollution level and cardiac arrhythmia were not fully understood. Hence, we investigated relationship between air pollutant levels with arrhythmia symptom exacerbation at an hourly timescale including modification by spatial synoptic classification (SSC) and demographic factors. Methods In this study conducted in Seoul, Korea in 2008-2011, arrhythmia-related emergency department (ED) visits were correlated with hourly data on particulate matter (PM) and ozone (O<sub>3</sub>) concentrations under the case-crossover analysis with the same year-month time stratification. The lag between an interquartile range increase in pollutant concentration and arrhythmia exacerbation was stratified as every 6 hours within 24 hours. Effect size [odds ratio (OR), 95% confidence interval (CI)] of increased pollutant levels on ED visits was analyzed according to SSC for the modification effect. In addition, gender, age, and socio-economic status (SES), in single- and multi-pollutant models after adjusting for meteorological variables. Measurements and Main Results Of 17,088 arrhythmia-related ED visits, 9,316 (54.5%) were by men, 8,189 (47.9%) by 20-64 year olds, and 16,114 (94.3%) by high SES patients. The highest adverse effect [OR, (95% CI)] was of 10 µm diameter PM (PM<sub>10</sub> after 1-6 h [1.03, (1.00-1.05)]), and of PM<sub>10-2.5</sub>, after 7-12 h [1.04, (1.00-1.08)] and the effect were stayed up to 19-24 h [1.04, (1.00-1.08)]. Effect of O<sub>3</sub> was age-modified with increased effect for the elderly greater than 65 years and the effect of PM and O<sub>3</sub> was modified by SSC with adverse effect in dry moderate [DM] after 1-6 h. Conclusions Increased PM and O<sub>3</sub> levels lead to increased risk of arrhythmia exacerbation and modified by the demographic factors and the type of SSC after adjusting meteorological variables.

## **P02.1060. Assessment of Personal Exposure to Near-Road PM2.5 Combining Measurements and Modelling Data**

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Abstract: Epidemiological studies have revealed significant associations between personal exposure to PM2.5 and adverse human health effects, in particular on the respiratory and cardiovascular systems. In urban areas, motor vehicles are significant sources of PM2.5 emissions. Although periods of personal exposure to PM2.5 outdoors are relatively short on a daily time scale, high acute exposure occurs during daily commutes. To estimate personal exposure to near-road PM2.5, a modelling system is proposed that integrates a traffic-emissions simulator, an atmospheric transport model and an exposure-inhalation model. PM2.5 inhalation concentrations are estimated for a cohort of male and female adults, and children at age 6 and 10 during cycling, running, walking, commuting and rest near-roads. Results show that PM2.5 inhalation is strongly correlated with exposure periods and physical activities. Adults exhibit higher PM2.5 inhalation than children due to higher respiratory rates for all physical activities considered. However, all personal profiles evaluated show that PM2.5 inhalation may increase between 1.5 to 5 times during morning and evening traffic rush hours compared with periods of lower traffic volume flow. Significant increases in inhalation are observed close to PM2.5 hot-spots such as road intersections, traffic light signs and traffic calming devices. This methodology identifies spatio-temporal critical areas near schools, hospitals, sport fields and other venues where susceptible receptors are highly exposed. The modelling system allows vehicle engine and emission technologies to be tested, and pedestrian and cycling routes to be chosen to minimise personal exposure.

## **P02.1070. A Community Driven Initiative to Investigate the Health Impacts of Exposure to Outdoor Air**

Paleah Moher

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Abstract: Aamjiwnaang First Nation is situated near the Sarnia-Lambton "Chemical Valley", an industrial complex of refining and chemical companies, with poor air quality, chemical spills and other environmental events. Residents of Aamjiwnaang are concerned about the health impacts of these environmental exposures. In past decades, Aamjiwnaang has been involved in approximately 20 environmental and health research studies. The aim of this project is to consolidate these data to describe a more complete account of exposure, in collaboration with the Health Committee at Aamjiwnaang to integrate academic tools with Indigenous knowledge. This initiative has three components: 1) a screening-level cancer risk assessment on the community's exposure to outdoor air; 2) a systematic review of the impact of environmental factors on health; 3) digital stories to portray community members' perspectives. We investigated current (2015-2016) and historical (1995-1996, 2005-2006) data from four nearby air monitoring stations to assess outdoor air exposures and to map air concentrations in the Sarnia area. The assessment found that air concentrations of several pollutants, including benzene, are improving overtime, however for all years investigated benzene levels are above the ambient air quality control (AAQC) target, which are set by Ontario's Ministry of Environment and Climate Change (MOECC). The concentrations of several pollutants, including benzene, were higher in Sarnia than provincial annual averages. The systematic review of the peer-reviewed literature found that there was evidence of exposure to environmental pollutants in this community. This work will contribute to an enhanced understanding of environmental impact on health among Aamjiwnaang residents, and highlights the importance of partnership to create actionable recommendations and products for First Nations communities.

## **P02.1080. The Association of Traffic-Related Air and Noise Pollution with Maternal Blood Pressure in the HOME Study**

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**Abstract:** Background: Traffic-related air and noise pollution may increase the risk for cardiovascular disorders, especially among vulnerable populations like pregnant women. Objective: To evaluate the association of exposure to elemental carbon attributable to traffic (ECAT, a marker of traffic-related air pollution) and traffic noise with maternal blood pressure. Methods: Systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements at >20 weeks gestation were assessed in the HOME Study, a prospective pregnancy and birth cohort from Cincinnati, OH (n=350). At women's residential address during pregnancy we estimated ECAT exposure using a validated land use regression model and roadway noise using a publicly available transportation noise model. We used linear mixed models to assess associations of blood pressure with ECAT and traffic noise after adjusting for covariates and early pregnancy blood pressure. Results: Women living in census tracts of lower neighborhood socioeconomic status were exposed to higher ECAT concentrations and were more likely to be exposed to traffic noise >35 dBA. Women in the highest versus lowest ECAT tercile had statistically significantly higher SBP in late pregnancy (2.8 mmHg, 95%CI=0.0, 5.5; p=0.047); the association was stronger after adjusting for traffic noise (3.1 mm Hg, 95%CI= 0.3, 5.9; p=0.030). Traffic noise was not independently associated with SBP or DBP, and ECAT was not associated with DBP. Additionally, there was no evidence of a joint effect of traffic noise and ECAT on blood pressure. Conclusion: In this cohort, estimated residential ECAT at ~20 weeks gestation was associated with higher SBP in late pregnancy. Future studies of traffic-related air or noise pollution should consider jointly adjusting for both exposures and neighborhood characteristics due to their correlations and potential associations with cardiovascular disorders.

## **P02.1090. Air Pollution, Land Use, and Complications of Pregnancy**

Seung-Ah Choe

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**Abstract:** Mounting evidence suggests that the natural and built environment can affect human health, but relatively few studies have considered links between features of the residential natural and built environment other than air pollution and complications of pregnancy. To quantify the impact of features of the maternal residential natural and built environments on risk of gestational diabetes mellitus (GDM), gestational hypertension and preeclampsia among 61,640 women who delivered at a single hospital in Rhode Island between 2002 and 2012. We estimated residential levels of ambient fine particulate matter (PM<sub>2.5</sub>) and black carbon (BC) using spatiotemporal models, neighborhood green space using remote sensing and proximity to recreational facilities, and neighborhood blue space using distance to coastal and fresh water. We used logistic regression to separately estimate the association between each feature and GDM, gestational hypertension, and preeclampsia, adjusting for individual and neighborhood markers of socioeconomic status. GDM, gestational hypertension, and preeclampsia were diagnosed in 8.0%, 5.0%, and 3.6% of women, respectively. We found 2nd trimester PM<sub>2.5</sub> (OR=1.08, 95% CI: 1.00, 1.15 per interquartile range increase in PM<sub>2.5</sub>) and living close to a major roadway (1.09, 95% CI: 1.00, 1.19) were associated with higher odds of GDM, while living <1km from the coast was associated with lower odds of GDM (0.87, 95% CI: 0.78, 0.96). Living <500m from a recreational facility was associated with lower odds of gestational hypertension (0.89, 95% CI: 0.80, 0.99). None of these features were associated with preeclampsia. Results were qualitatively similar in mutually-adjusted models and sensitivity analyses. In this medium-sized coastal US state, risk of GDM was positively associated with PM<sub>2.5</sub> and proximity to busy roadways, and negatively associated with proximity to blue space, highlighting the importance of the natural and built environment to maternal health.

## **P02.1110. Air Pollution Exposure and Risk of Spontaneous Abortion in the Nurses' Health Study II**

Audrey Gaskins

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**Abstract:** Background/Aim: A growing literature suggests that air pollution adversely affects early pregnancy outcomes, particularly pregnancy loss; however the evidence is limited. The objective of this study was to examine whether air pollution exposures are associated with risk of spontaneous abortion (SAB). Methods: Our prospective cohort study included 19,309 women in the Nurses' Health Study II who contributed a total of 35,025 pregnancies between 1990 and 2008. Proximity to major roadways and exposure to particulate matter <10 microns (PM<sub>10</sub>), 2.5-10 microns (PM<sub>2.5-10</sub>), and <2.5 microns (PM<sub>2.5</sub>) were determined for residential addresses between 1989 and 2007. Multivariable log-binomial regression models with generalized estimating equations were used to estimate the risk ratios (RRs) and 95% confidence intervals (CIs) of SAB. We also conducted a bidirectional case-crossover analysis among 3,693 women (11,805 pregnancies) with at least one SAB and at least one control pregnancy during follow-up using conditional logistic regression. Results: During the 19 years of follow-up, 6599 SABs (18.8%) were reported. In the main analysis, living closer to a major roadway and average exposure to PM<sub>10</sub>, PM<sub>10-2.5</sub>, or PM<sub>2.5</sub> in the year prior to pregnancy were not associated with an increased risk of SAB. However, in the case-crossover analysis, each 10 µg/m increase in PM<sub>10</sub>, PM<sub>2.5-10</sub>, and PM<sub>2.5</sub> in the year prior to pregnancy was associated with 1.27 (95% CI 1.11, 1.46), 1.35 (95% CI 1.09, 1.66), and 1.51 (95% CI 1.15, 1.97) higher odds of SAB, respectively. Conclusion: Higher exposure to air pollution within a woman in the year prior to pregnancy may be associated with increased risk of SAB.

## **P02.1120. Exploring Association of Long-Term Ultrafine Particle Exposure with IL-1 $\beta$**

Doug Brugge

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**Abstract:** Introduction: Traffic related ultrafine particles (UFP) are increasingly reported to be associated with adverse health outcomes and biomarkers of sterile inflammation. IL-1 $\beta$  is a core driver of inflammation that is a product of activation of the inflammasome. IL-1 $\beta$  has been associated with exposure to other sizes of particulate matter which led us to explore associations with UFP. Methods: We analyzed plasma samples stored at -80°C from the Community Assessment of Freeway Exposure and Health study (CAFEH; N=389). Samples were assayed for IL-1 $\beta$  by ELISA using the Quantikine HS Human IL-1 beta Immunoassay. Individual UFP exposure had previously been assigned to these participants as time activity adjusted particle number concentration (TAA-PNC). Annual average exposure ranged from 9,000 - 35,000 particles/cm<sup>3</sup>. The majority of participants (54%) had an IL-1 $\beta$  below the LOD (0.125 pg/mL), therefore we dichotomized IL-1 $\beta$  to over or under the LOD and conducted logistic regression analysis adjusting for age, gender, BMI, race and smoking status. We also conducted a generalized linear regression analysis for associations in participants with a value above the LOD. Results: TAA-PNC was associated with IL-1 $\beta$  in our adjusted logistic regression model. For every 1,000 particles/cm<sup>2</sup> increase in exposure there was a 4% (95%CI: 0.4%, 7.3%) increase in the odds of having a detectable level of IL-1 $\beta$ . We found no meaningful association of TAA-PNC with IL-1 $\beta$  using generalized linear regression analysis. Conclusions: We found some evidence of an association of UFP with plasma IL-1 $\beta$  levels, however further research is needed.

**P02.1140. Air Pollution-Related Health and Health Equity Effects of the United States Economy: 1997-2015**

Christopher Tessum

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**Abstract:** Outdoor fine particulate matter (PM<sub>2.5</sub>) air pollution is a major cause of death in the United States. We explore the relationships among PM<sub>2.5</sub> health impacts, sources of the responsible emissions, and the economic demand that induces those emissions. We create a spatially-explicit environmentally-extended economic input-output model for the United States by coupling economic input-output and consumption data with spatially-explicit emissions data, a reduced-complexity air quality model, and spatially-explicit population and health data. The resulting model relates air pollution emissions, concentrations, and health impacts with economic activity in the United States at a spatial scale varying between 1 and 48 km (depending on population density). We find that of 180,000 air quality-related mortalities in year-2014, 75% were induced by economic demand. Individuals identifying as Black or African-American and Hispanic or Latino were exposed to 65% more personal-consumption-induced PM<sub>2.5</sub> than what would be equitable given their level of personal consumption. Between 1997 and 2015, reductions in emissions per unit production reduced demand-related air pollution mortalities by 35% despite increasing population and per-capita economic consumption; corresponding race-ethnicity inequity has decreased more slowly.

**P02.1150. Cardiovascular Mortality Reductions Related to Improved Air Quality Vary by Socioeconomic Status: A Moderated Mediation Analysis**

Lauren Wyatt

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**Abstract:** Background: Chronic air pollution exposure is a risk factor for cardiovascular disease (CVD) and recent work suggests that CVD mortality reduction over time is partially attributed to improved air quality. We assessed the extent that mortality reduction via PM<sub>2.5</sub> change varies by county characteristics and focused on socioeconomic (SES) variables (income, poverty, and unemployment), initial air pollution and sources, employment by sector, and built environment. Methods: Data for 2,132 US counties between 1990 and 2010 included annual age standardized mortality rates from the US National Center for Health Statistics, annual average PM<sub>2.5</sub> concentrations from the US Environmental Protection Agency's Community Multiscale Air Quality (CMAQ) modeling framework, baseline SES, and county urbanization level (metropolitan, metro; non-metropolitan, non-metro). A moderated mediation analysis using weighted linear models measured how the indirect effect on CVD mortality via PM<sub>2.5</sub> is moderated by county SES status and urbanization level. Average mediation at different levels of SES were estimated from bootstrap replications. Results: In a preliminary analysis, SES moderated the PM<sub>2.5</sub>-mediated cardiovascular trend differently in metro and non-metro counties. Trends in annual PM<sub>2.5</sub> reduction and the health benefit (mortality reduction) per 1 microgram PM<sub>2.5</sub> by SES status were similar between metro and non-metro counties. PM<sub>2.5</sub> reductions were greatest in counties with higher income, lower poverty, and lower unemployment, while the largest health benefits were observed in counties with lower SES status. In metro counties, PM<sub>2.5</sub> mediation was moderated by county poverty level, with increased mediation in counties with greater poverty. In non-metro counties, mediation via PM<sub>2.5</sub> was consistent for all poverty levels. Conclusions: We identified that PM mediated health benefits were greatest in metropolitan counties with greater SES status. This abstract does not reflect EPA policy.

**P02.1160. Source Specific-PM2.5 Associated with Heart Rate Variability in Elderly Adults with Coronary Diseases: A Community-Based Panel Study**

Xi Chen

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**Abstract:** Background: Heart rate variability(HRV) is an important predictor of cardiovascular disease, and evidence for an association between ambient particulate matter exposure and HRV is increasing, but little is known about the relative contribution of various sources and toxicity of particle components. Objective: To compare short-term effects of fine particulates (PM2.5) from different sources on the HRV and blood levels of C-reactive protein (CRP). Methods: HRV and CRP levels were measured at monthly clinic visits in panels of elderly subjects with coronary heart disease from Gaojing community in east Beijing in early 2017. 24 patients were followed for 4 months and the visits of every subjects were always scheduled for the same weekday. Daily outdoor levels of PM2.5 and its related chemical components were measured at one central site within the community and personal time-activity patterns information was collected concurrently with the visits. PM2.5 was identified between main sources using positive matrix factorization. The individual exposures were estimated through micro-environmental model. We linked source-specific PM2.5 with HRV and CRP levels using mixed model to evaluate the toxicity of particle components for cardiovascular effects of PM. Results:pNN50 and rMSSD as sensitivity indicators were filtered and lagging effects of exposure to PM2.5 and PM2.5-Pb were observed. By comparing diverse models, it confirmed that the estimates for health effects of lag6 to lag3 exposure to PM2.5 and related chemical components were significantly different. For pNN50, exposure to PM2.5 could cooperate with the effect of temperature on cardiovascular health. When controlling exposures to PM2.5 and PM2.5-Pb, protective effects of Beta-blocker use on cardiovascular health were observed. Conclusions: Our results suggest that differences in the components of particles, Beta-blocker use, and gender of study subjects may explain some inconsistencies among previous studies on HRV.

**P02.1170. Geographically Varied Associations between Hypertensive Disorders in Pregnancy and Particulate Matter in the Contiguous United States, 1999-2004**

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Abstract: Hypertensive disorders in pregnancy harm both maternal and infant health and have been linked to ambient particulate matter (including PM<sub>2.5</sub> and PM<sub>10</sub>). However, existing studies are restricted to a local-scale and remain inconsistent. A large-scale study is required to enrich the epidemiological evidence and explore the potential sources of the inconsistency. Making use of United States birth certificates (1999-2004), and monitoring data from the environmental protection agency air quality networks, we associated hypertensive disorders in pregnancy with maternal exposure to PM<sub>2.5</sub> or PM<sub>10</sub> using logistic regression analysis after adjusting for many covariates among more than 5 million subjects in the contiguous United States. Additional analyses were conducted to examine variations in the associations according to: (1) Census divisions; (2) Individual-level factors; (3) A socioeconomic indicator, county-level poverty; and (4) The concentration of ambient particles. The results indicated that hypertensive disorders in pregnancy was robustly linked to maternal exposure to PM<sub>2.5</sub> with an adjusted odds ratio of 1.10 (95% confidence intervals, 1.08-1.12) per 5 µg/m<sup>3</sup> increment in terms of the entire-pregnancy mean. Stronger associations were found among white mothers. There were also considerable variations in the association by census division or poverty level among counties. Nonlinear analysis indicated a sublinear dose-response function with a threshold concentration of 9 µg/m<sup>3</sup>. Based on the national study, we calculated the population attributable fractions and found that 8.1% (6.8%-9.4%) of hypertensive disorder cases were attributable to an entire-pregnancy exposure of PM<sub>2.5</sub>. These findings can help policymakers to plan related interventions.

## **P02.1180. Assessing Determinants of Sustained Fuel Transitions.**

John Atkinson

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**Abstract:** Solid fuel combustion remains a dominant energy source for household heating and cooking in low- and middle-income countries. As a result, almost three billion people are exposed to indoor air pollution, causing four million premature deaths annually, primarily among poor women and children. We analyze Demographic and Health Surveys from 69 countries, in combination with data from the World Bank (World Development Indicators) and the United Nations (energy production data) to identify variables associated with successful fuel transitions. We evaluate cross-country variation in solid fuel use using population-average linear regression in a series of models: Population, Socio-economic, Political, Energy, and Pooled models. The pooled model shows that population density, population size, rural population share, income inequality, and charcoal production are positively associated with countries' solid fuel use, while GDP per capita, electricity production, and natural gas production have a negative relationship with solid fuel use. Economic development (GDP per capita) is the most substantively significant variable for predicting solid fuel use: A standard deviation increase in per capita GDP above its mean reduces solid fuel use from 70.2% to 57.1% of households. Population size is another strong predictor: solid fuel use rises from 70.2% to 78.8% when population size increases by one standard deviation above the mean. Finally, using fixed-effects linear regression, we estimate within-country changes in solid fuel use with time. In the pooled model, increasing population size is related to increases in solid fuel use, while increases in GDP per capita and the presence of government programs promoting renewable energy lead to a reduction in solid fuel use. Identifying evidence-based factors that foster clean fuel transitions is expected to inform improvements in indoor air quality, thereby benefitting public health and reducing mortality and morbidity.

## **P02.1190. Characterizing Personal Fine and Ultrafine Particle Exposures among Inner-City Children with Asthma**

Ehsan Majd

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**Abstract:** The PEAK study aims to determine the association of particle size, microenvironment (ME) and peak exposure with respiratory effects in children with asthma. 25 children aged 8-17 with asthma were each followed for 4 consecutive days. Children's personal PM<sub>2.5</sub> (particles with diameter less than 2.5  $\mu\text{m}$ ) and ultrafine particle (UFP, diameter less than 0.1  $\mu\text{m}$ ) exposures were measured at high spatiotemporal resolutions using a backpack containing personal PM<sub>2.5</sub> and UFP (expressed as LDSA, lung-deposited surface area) monitors and a GPS for geographic location (logging interval= 10 seconds). Information about means of transportation used, places visited, and activities at home that may have resulted in high exposures were also obtained. Exposures were partitioned into five MEs: Home, School, Vehicle transport, Pedestrian transport, and Other. PM<sub>2.5</sub> and UFP cumulative exposures were dominated by Home. Mean UFP exposure intensities while in Pedestrian transport and Vehicle transport were both greater than 1 and higher than PM<sub>2.5</sub>. Exposure intensities while in Pedestrian transport were also greater than Vehicle transport. Correlations between PM<sub>2.5</sub> and LDSA concentrations were examined to evaluate the need for personal UFP exposure monitoring in addition to the commonly-monitored PM<sub>2.5</sub>. The highest and lowest mean PM<sub>2.5</sub>/LDSA correlation coefficients belonged to Home ( $r=0.47$ ) and Vehicle transport ( $r=0.15$ ). Home pollutant correlations were particularly weak (high UFP and low PM<sub>2.5</sub>) during evening hours and coincided with common household activities such as cooking, cleaning, and burning candles/incense. Our findings suggest that UFP exposure is only weakly to moderately correlated with fine PM exposure, suggesting that personal exposure monitoring at high spatiotemporal resolutions and including UFP to personal exposure monitoring campaigns, may be important to fully understand the effect of particulate exposures in susceptible populations such as children with asthma.

## **P02.1200. Household Air Pollution and Arthritis in Low- and Middle-Income Countries: Evidence from the World Health Organization's Study on Global Ageing and Adult Health**

Shelby Yamamoto

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Abstract: Evidence points to a clear link between air pollution exposure and several chronic diseases. However, investigations regarding arthritis are still lacking. Ambient air pollution and smoking have been associated with a higher risk of rheumatoid arthritis, though the evidence regarding osteoarthritis is inconsistent. Further, most of this evidence stems from high-income countries. Household air pollution exposure may be an important risk factor for arthritis in low- and middle-income countries (LMICs) but is largely unstudied. Women in these regions can be exposed to high levels of air pollution through cooking activities. Women, in general, are also at higher risk of arthritis, compared to men. We examined household air pollution (electricity vs. gas/kerosene/paraffin; coal/charcoal/wood; or agriculture/crop/animal dung/shrubs/grass used for cooking) as a risk factor for arthritis in 6 LMICs (China, Ghana, India, Mexico, the Russian Federation and South Africa) using data from Wave I of the multiwave panel World Health Organization Study on Global AGEing and Adult Health (SAGE) (2007-2010). The use of liquid (aOR=1.73, 95%CI: 1.33-2.25) or solid (coal/charcoal/wood: AOR=1.73, 95%CI: 1.32-2.27; agriculture/crop/animal dung/shrubs/grass: AOR=2.00 (1.47-2.72) for cooking was strongly associated with an increased odds of arthritis, compared to electricity, in pooled weighted analyses. Sex (female), age ( $\geq 50$  years), obesity (BMI  $\geq 30.00$ ) and the comorbidities angina pectoris, diabetes, chronic lung disease, depression and hypertension were also associated with a higher odds of arthritis. Underweight (BMI  $< 18.50$ ) and higher education levels (college/university completed/post-graduate) were associated with a lower odds of arthritis. This study is among the first to examine household air pollution in LMICs as a risk factor for arthritis. These findings suggest that exposure to household air pollution might be associated with an increased odds of arthritis in these regions.

## **P02.1210. Long-Term Exposure to Ambient PM2.5 and Fasting Blood-Glucose in the Elder Cohort**

Yi Zhang

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**Abstract:** Background/Aim: Diabetes is one of the major diseases affecting the human health and bringing the heavy disease burden. There are only a few studies which have reported the effects of long-term PM2.5 exposure on the fasting blood-glucose among the elders. Most of them are cross-sectional studies, and the results are inconsistent. Therefore, we have conducted a longitudinal study to determine the association between long-term exposure to ambient PM2.5 and fasting blood-glucose in the elder cohort. Methods: We have followed up 609 subjects older than 60 years subjects in the six counties in China in 2008-2009, 2012 and 2014 in three times. The subjects that accepted fasting blood-glucose test more than once have been included (589 remained in the analysis). The ambient annual ground-level PM2.5 concentration with 0.01°spatial resolution from 2005-2014 was obtained from Atmospheric Composition Analysis Group, Dalhousie University, Canada. The linear mixed effect models were used in the analysis between the PM2.5 and fasting blood-glucose. The main analysis model was adjusted for random subject and county effect, and age, sex, education years, et al. as the fixed effect. Results: The increase of 10µg/m<sup>3</sup> in annual exposure to PM2.5 in the previous year was associated with an increase of the fasting blood-glucose of 0.281 mmol/L (95% confidence interval [CI], 0.169 to 0.393). The subgroup with diabetes had a higher estimated increase of the fasting blood-glucose than the subgroup without diabetes (Z=2.87, P<0.01); the subgroup without exercise regularly had higher estimated increase of the fasting blood-glucose than the subgroup with exercise regularly (Z=2.26, P<0.05). Conclusions: The long-term ambient PM2.5 exposure is associated with the increase of the fasting blood-glucose. The elders with the diabetes are the vulnerable people. And doing exercise regularly is a protective factor.

## **P02.1220. Effects on Morbidity and Mortality of Critical Episodes of PM2.5 in the City of Medellin, 2015**

Juan Piñeros Jiménez

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**Abstract:** Two critical episodes of PM2.5 were observed in Medellin (level over 75 mg/m<sup>3</sup> for three days or more) on March 15-18 and March 25-28, 2015. The association between acute exposure to PM2.5 during episodes and daily cases of mortality and morbidity and emergency room visits in population under 5 years and adults aged 65 and over was examined in the quarter between February and April 2015. Statistical analyzes of interrupted time series and generalized additive models of Poisson regression were performed. During the episodes, the increase of 10 mg/m<sup>3</sup> in the daily average of PM2.5 was associated with the increase of 4.6% and 6.1% in emergency room visits of children under 5 years of age due to respiratory infection and pneumonia in the same day of the increase, and variations of 6.2% and 4.6% for the cumulative exposure of seven days, respectively. For this age group increases in 3.3% for incident cases of respiratory infection and 5.5% for pneumonia were reported in the same day of exposure and in 6.7% in the distributed delay of 0-7 for both. For all ages and adults 65 and older, the cumulative effects of mortality from respiratory caused increased 2.4% and 4.5%, respectively, per 10 mg/m<sup>3</sup> in the daily average of PM2.5 after 7-day exposure. Compared with the days of the February-April quarter in which the atmospheric episode did not appear on the days of critical episodes, children under 5 years of age presented an excess of 39.4% in emergency room visits due to pneumonia and 22.7% due to respiratory infection. In the same age group, incident cases of pneumonia and respiratory infection increased by 20.9% and 16.15%, respectively, there was also an excess of 13.2% in the asthma crisis. This study report excesses of morbidity and emergency room visits in children under 5 years old during critical episodes in Medellin.

## **P02.1230. Identifying Sensitive Windows for Prenatal Particulate Air Pollution Exposure and Relative Leukocyte Telomere Length in Cord Blood**

Maria Jose Rosa

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**Abstract:** Introduction: In utero particulate matter exposure produces oxidative stress that impacts cellular processes that include telomere biology. Newborn telomere length is likely critical to an individual's telomere biology; reduction in this initial telomere setting may result in increased susceptibility to adverse outcomes later in life. We implemented innovative methodology to identify sensitive windows for the associations between prenatal particulate matter with diameter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) and relative leukocyte telomere length (LTL) measured in cord blood. Methods: Women who were residents of Mexico City and affiliated with the Mexican social security system (IMSS) were recruited during pregnancy (n=427 for analyses). Mothers' prenatal exposure to PM<sub>2.5</sub> was estimated based on residence during pregnancy using a satellite-based spatio-temporally resolved prediction model. Cord blood was obtained at the time of delivery and leukocyte DNA was extracted. Duplex quantitative polymerase chain reaction (qPCR) was used to compare the relative amplification of the telomere repeat copy number to single gene (albumin) copy number. A distributed lag model (DLM) incorporating weekly averages was used in order to explore sensitive windows. A sensitive window was identified when the pointwise 95% confidence bands did not contain zero. Results: In models that included child's sex, mother's age at delivery, prenatal environmental tobacco smoke (ETS) exposure, gestational age, birth season and assay batch, we found significant associations between higher PM<sub>2.5</sub> exposure during early pregnancy (4-9 weeks) and shorter LTL in cord blood. A 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub> during this period resulted in an 8.6% shortening in LTL. Conclusions: Increased PM<sub>2.5</sub> during a specific prenatal window was associated with shorter LTL. Refined determination of time window in which PM has the greatest magnitude of effect can enhance insight into underlying mechanisms.

## **P02.1240. Maternal Exposure to Ambient Ozone and Congenital Diseases in Korea**

Kyung-Shin Lee

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**Abstract:** Previous studies suggested evidence of an effect of exposure to ambient air pollutants on risk of certain congenital heart and structural defects. However, few studies have investigated the effects on endocrine and metabolic diseases. We estimated associations between maternal exposure to ambient ozone (O<sub>3</sub>) and congenital malformations and endocrine and metabolic diseases in Korea. Among infants residing in 251 districts in Korea, cases with 11 congenital anomalies (n=149,325) and controls with non-infective gastroenteritis and colitis (n=1,172,764) at birth were selected from the National Health Insurance Cohort Data during 2008-2013. For each infant, we assigned the various definitions of exposure period based on pregnancy trimesters (1st, 2nd, 3rd, 1st to 2nd, 2nd to 3rd, and 1st to 3rd). Mean of O<sub>3</sub> concentrations prior to the birth was used as a proxy of exposure for the pregnant women based on the residential area. We estimated the effects of O<sub>3</sub> on 11 types of congenital diseases using logistic regression models after controlling for covariates such as sex, income, and year. We observed marginal and significant associations between maternal exposure to O<sub>3</sub> and metabolic diseases and congenital malformations. Maternal O<sub>3</sub> exposure was positively associated with increases in metabolic diseases, 5.4% [95% Confidence Intervals (CI), 0.3%, 10.8%], circulatory system, 9.3% (95% CI, 3.6%, 15.4%), and musculoskeletal system, 5.9% (95% CI, 1.6%, 10.2%). However, there is no significant association between maternal O<sub>3</sub> exposure and the nervous and digestive systems. **Conclusions:** The study contributes to the small body of knowledge regarding the associations between in utero exposure to ozone and congenital and metabolic anomalies, but confirmation of these associations will be needed in future studies. **Funding:** This study was partially supported by grants from the Environmental Health Center funded by the Ministry of Environment, Republic of Korea.

**P02.1250. A Population-Based Study of Traffic-Related and Outdoor Air Pollution during Pregnancy and Autism in Denmark**

Qi Yan

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**Abstract:** Background Previous autism spectrum disorder (ASD) and air pollution studies focused on pregnancy exposures, but another vulnerable period is immediate postnatally. Here, we examined early life exposures to air pollution from the pre- to the postnatal period and ASD/ASD subtypes in the Danish population. Methods With Danish registers, we conducted a nationwide case-control study of 15,387 children with ASD born 1989-2013 and 68,139 population controls matched by birth year and sex identified from the birth registry. We generated air dispersion model (AirGIS) estimates for NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>2.5</sub> and PM<sub>10</sub> at mothers' home from 9 months before to 9 months after pregnancy and calculated odds ratios (OR) and 95% confidence intervals (CI), adjusting for parental age, neighborhood socioeconomic indicators, and maternal smoking using conditional logistic regression. Results In models that included all exposure periods, we estimated adjusted ORs for ASD per interquartile range (IQR) increase for 9 month after pregnancy with NO<sub>2</sub> of 1.08 (95% CI: 1.01, 1.15) and with PM<sub>2.5</sub> of 1.06 (95% CI: 1.01, 1.11); associations were smaller for PM<sub>10</sub> (1.04; 95% CI: 1.00, 1.09) and strongest for SO<sub>2</sub> (1.21; 95% CI: 1.13, 1.29). Also, associations for pollutants were stronger in more recent years (2000-2013) and in larger cities compared with provincial towns/rural counties. For particles and NO<sub>2</sub>, associations were only specific to autism and Asperger diagnoses. Conclusion Our data suggest that air pollutant exposure in early infancy but not during pregnancy increases the risk of being diagnosed with autism and Asperger among children born in Denmark.

## **P02.1260. Prenatal and Postnatal Ambient Air Pollution Exposure and Weight Growth Trajectories in Early Childhood**

Anna Rosofsky

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**Abstract:** Background: Air pollution exposure during pregnancy has been positively associated with both low birth weight and higher body mass index later in life. The relationship between perinatal air pollution exposure and weight growth trajectories in early childhood, and the interaction with birth weight has yet to be studied. Methods: We combined electronic medical record (EMR) with survey data collected from caregiver-child dyads enrolled in the ethnically diverse Boston-based Children's HealthWatch cohort (n=4,797). Geocoded residential address at each EMR entry was linked to daily 1 km<sup>2</sup> PM<sub>2.5</sub> predictions. We examined the association between pre- and postnatal (12-month averaging period) PM<sub>2.5</sub> exposure and sex-specific weight (kg) growth trajectories from birth to age six, using piecewise linear and polynomial mixed models. Results: Mean prenatal and postnatal PM<sub>2.5</sub> concentrations were similar between males (prenatal: 9.6 ±1.2 µg/m<sup>3</sup>; postnatal: 7.9 ±0.9 µg/m<sup>3</sup>) and females (prenatal: 9.5 ±1.2 µg/m<sup>3</sup>; postnatal: 7.9 ±1.0 µg/m<sup>3</sup>). Females with prenatal PM<sub>2.5</sub> above the median (9.5 µg/m<sup>3</sup>) had significantly (p<0.05) higher weights versus females with prenatal PM<sub>2.5</sub> below the median from 0-6 years of age (e.g. 0.16 kg higher at 24 months, 0.62 kg higher at 60 months). The association was similar among low birth weight (LBW) (< 2500 g) females (13.3% LBW). Conversely, males with prenatal PM<sub>2.5</sub> above the median had lower weights (e.g. -0.17 kg at 24 months, -0.72 kg at 60 months) than males with prenatal PM<sub>2.5</sub> below the median. Male weight trajectories did not differ by birth weight strata (14.1% LBW). Weight trajectories were not associated with postnatal PM<sub>2.5</sub>. Conclusions: Studying growth trajectories provides an opportunity to understand the life course impact of pre and postnatal air pollution. The findings demonstrate the complex association between environmental exposures and childhood weight gain and that the mechanism of sex-specific effects require additional research.

## **P02.1270. Air Pollution Exposure and Biomarkers of Early Effect in Children: The Final Results of the MAPEC\_LIFE Project**

Umberto Gelatti

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**Abstract:** Children are at high risk of suffering health consequences of air pollution and childhood exposure can increase the risk of developing chronic diseases in adulthood. The MAPEC\_LIFE project, funded by EU Life+ Programme (LIFE12 ENV/IT/000614), aimed to evaluate the association between air pollution exposure and biomarkers of early effect in children, and to propose guidance for implementing environmental policies. The study was carried out on 6-8-year-old children living in 5 Italian towns in two different seasons. DNA strand breakage and micronucleus (MN) frequency were investigated in buccal cells of children. Socio-demographic and lifestyle features were investigated using a questionnaire. Air pollution exposure was assessed analysing PM0.5 for chemical composition, toxicity and genotoxicity and collecting data on air quality during the study period. 1149 children were included. Levels of main pollutants were higher in the Northern Italy and in winter. PM0.5 extracts showed slight cytotoxic and mutagenic effects. In winter, the 52.7% of children showed at least one MN in cells (0.44 MN/1000 cells), with significant differences among the towns. In spring, MN frequency was lower than in winter (0.22 MN/1000 cells) and the difference between towns disappears. MN frequency resulted associated with benzene, PM2.5, ozone, SO2 and polycyclic aromatic hydrocarbons. Environmental tobacco smoke, BMI and diet showed to influence MN frequency, as well. DNA strand breakage was higher in spring (179.02 au) than in winter (159.00 au) with significant differences among the towns (only in winter). DNA damage was associated with benzene, PM2.5, SO2, NO2 and ozone. Socio-demographic and lifestyle features did not influence the damage. In conclusion, the assessment of biomarkers of early effect in the population is useful in evaluating the impact of air pollution exposure. Results obtained can be used to propose some guidance for implementing policies for public health protection.

**P02.1280. Oxidative Potential and Metals in Ambient Particulate Matter are Associated with Inflammatory and Neural Biomarkers in a Controlled Exposure Study**

Ling Liu

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**Abstract:** Background: Oxidative stress/inflammation is an important pathway leading to particulate matter-associated disease status. We studied the effects of metals and oxidative potential (OP) in urban particles on biomarkers of systemic inflammation, oxidative stress and neural function. Methods: Fifty-five healthy non-smoking volunteers, mean age 28 years, were exposed to coarse (2.5-10  $\mu\text{m}$ , mean 213  $\mu\text{g}/\text{m}^3$ ), fine (0.15-2.5  $\mu\text{m}$ , 238  $\mu\text{g}/\text{m}^3$ ), and/or ultrafine concentrated ambient particles (<0.3  $\mu\text{m}$ , 136  $\mu\text{g}/\text{m}^3$ ). Exposures lasted 130 minutes, separated by  $\geq 2$  weeks. OP (ascorbate or glutathione depletion in synthetic lung fluid) and metals in particles were measured. Blood and urine samples were collected pre-exposure, and 1-hr and 21-hr post exposure to determine biomarkers. We used mixed-regression models to assess associations between exposures and changes in biomarker levels adjusting for age, sex, BMI, season, particle size and mass. Results: Results were expressed as percent change from daily pre-exposure biomarker levels per mean pollutant concentration. Exposure to OP was significantly associated with increased blood inflammatory and neural biomarkers. E.g. C-reactive protein increased 146% (95% CI 44%-248%), neural biomarker ubiquitin C-terminal hydrolase L1 (UCHL1) increased 9.4% (1.8%-17.1%), and urinary lipid oxidation marker malondialdehyde (MDA) increased 19.4% (3.6%-35.3%) 21 hours post exposure. Exposure to various metals (Al, Cu, K, Ni, Sn, Ti and/or V) were significantly associated with increased blood interleukin-6 and blood and urinary VEGF, blood neural markers UCHL1, and urinary vanillylmandelic acid, homovanillic acid and cortisol, and urinary DNA oxidation marker 8-hydroxy-deoxy-guanosine and blood MDA. OP and metals were moderately correlated. Conclusion: OP and metals in ambient particles may influence biomarker levels that reflect systemic inflammation, oxidative stress, perturbations of blood-brain barrier integrity and physiological stress.

## **P02.1290. A Structural Approach to Analyzing Urban Population Dust Exposure and Its Effect on Daily Morbidity**

Asfandyar Shahab

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Abstract: Urban population is often challenged by high dust exposure and suffered with various health effects. Daily morbidity due to exposure is difficult to analyze since exposure time, human susceptibility and surviving effects varies. We propose an alternative approach for reducing bias linked with time-varying confounding variables. Urban population groups in Rawalpindi city including students, traffic police wardens, bus-drivers and students were analyzed. We aimed to assess dust exposure effects owing to job nature and time spend on road on daily morbidity, using time-series model ARIMA (Autoregressive Integrated Moving Average), to adjust time-varying confounding factors. We also apply a logistic regression model and compare both b-estimation outcomes with standard principal component generated scores for morbidity. Job titles were analyzed for exposure hazards using b-estimation in urban cohorts (n=358) on total and respiratory infection morbidity. Findings derived from ARIMA revealed daily dust exposure (7:00 to 9:00am) and job nature as strong predictors for upper respiratory tract infections. The Risk Ratio obtained from logistic model to total mortality compared with overall morbidity of urban population for the duration of follow up to the risk had nobody been exposed was 2.33 (CI: 1.03-4.26), and asthma risk ratio morbidity was 1.69 (CI: 1.16-3.97). Scores derived from principal component analysis for physical symptoms (sneezing, cough, eye redness, and eye irritation) were similar to hazard ratio approximations that lead to frequent hospital emergency room visits per month. Our study conclude that effect estimate for daily morbidity is highest for bus-drivers as they spend more time on road followed by traffic warden and students. The differential effect among study cohorts may partially show exposure time as prime determinant of health effects and hence interventions in the form of reduced job hours and use of masks are suggested to reduce exposure.

**P02.1300. Associations between High Air Pollutant Levels and Cardiovascular Diseases in Taipei, Taiwan**

How-Ran Guo

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**Abstract:** The association between air pollution and the occurrence of cardiovascular diseases has been demonstrated in many epidemiological studies. Extreme air pollution levels such as those resulted from meteorological events might affect the human health differently than the lower ones. However, in most studies, the effects of these extreme conditions were not evaluated separately. Therefore, we conducted a study to explore the association between high levels of air pollutants and cardiovascular diseases in Taipei City in Taiwan. We retrieved data on the outpatient visits between January 1, 2006 and December 31, 2010 from the National Health Insurance Research Database (NHIRD), which contain all the claims from a random sample of one million people. We obtained data on ambient levels of carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), and particulate matters less than 2.5 microns (PM<sub>2.5</sub>) and 10 microns (PM<sub>10</sub>) in diameter from five air quality monitoring stations in Taipei. A quantile regression model was used to evaluate the associations between the 3-day moving average of population weighted concentrations of the pollutants and the number of outpatient visits for cardiovascular diseases. During the study period, the cohort members paid a total of 191974 outpatient visits for cardiovascular diseases. According to the estimating parameter of least absolute deviations, we found that the quantiles of CO, O<sub>3</sub>, NO, NO<sub>2</sub> and PM<sub>10</sub> did not have stable relationship with visits for cardiovascular diseases, except for PM<sub>2.5</sub>. We observed a positive correlation between the level of PM<sub>2.5</sub> and the number of outpatient visits for cardiovascular diseases. In particular, the estimating parameter was higher than 0.6 when the 3-days moving average of PM<sub>2.5</sub> level was higher than 44.29 µg/m<sup>3</sup> (i.e. the 90th quantile). Therefore, the government should consider alarming patients with cardiovascular diseases when the ambient PM<sub>2.5</sub> is expected to reach a certain level.

## **P02.1310. Exposure to Ambient Air Pollution Associated with Increased Risk of Incident Diabetes Mellitus: A Population-Based Cohort Study**

Lauren Paul

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**Abstract:** Background/Aim: Diabetes research has recently taken into consideration the potential influence of air pollution on diabetes risk. However, epidemiologic evidence linking air pollution to diabetes remains inconsistent. This study sought to assess the relationship between selected air pollutants (NO<sub>2</sub>, PM<sub>2.5</sub>, O<sub>3</sub>, and Ox [oxidant capacity]) and the incidence of diabetes. Methods: Our cohort consisted of ~4.8M adults aged 35 to 85 who were long-term Ontario residents prior to cohort inception in 2001. The cohort was followed until 2015. Long-term exposure to NO<sub>2</sub>, PM<sub>2.5</sub>, and O<sub>3</sub> was estimated using satellite-based remote sensing, land-use regression model, and fusion-based approach, respectively, and was assigned to subjects' annual postal code addresses. Ox was calculated as the redox-weighted average of O<sub>3</sub> and NO<sub>2</sub>. Diabetes incidence was ascertained using population-based health administrative data with a validated algorithm. For each air pollutant, we estimated its association with diabetes using standard Cox proportional hazards models, adjusting for multiple individual-level and area-level covariates (e.g., SES and healthcare accessibility). We performed sensitivity and stratified analyses to assess the robustness of the estimates, and modelled the shape of air pollutant-diabetes associations using Shape Constrained Health Impact Functions. Results: Over the study period, 790,461 cohort members were diagnosed with diabetes. We found that each IQR increase in exposure to NO<sub>2</sub> was associated with a hazard ratio of 1.06 (95% CI: 1.05-1.06). This relationship was relatively robust to sensitivity analyses considered, and exhibited a near-linear shape. There were positive associations between diabetes and PM<sub>2.5</sub> (1.02 per IQR, 95% CI: 1.01-1.02), O<sub>3</sub> (1.002 per IQR, 95% CI: 0.999-1.01), and Ox (1.01 per IQR, 95% CI: 1.01-1.01), but these estimates were sensitive to different models considered. Conclusions: Air pollution, especially NO<sub>2</sub>, was linked to increased diabetes risk.

**P02.1320. Association of the daily ratio of FEV1 to FVC with the real-time exposure level to indoor PM2.5 and CO2 after controlling for other risk factors in adult non-smoking refractory asthmatics in urban areas of South Korea: Results from Environmental Health St**

Sol Yu

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**Abstract:** Background As acute exacerbations of refractory asthma (RA) can be fatal, it is important to recognize the risk factors with consideration that the immune system may undergo continuing change by age among adults and adult asthmatics tend to stay indoor. We evaluated the associations between variation in daily exposure levels to indoor air quality, and daily changes in lung function (FEV1/FVC ratio) of RA sufferers, after controlling for total immunoglobulin E (IgE) levels, smoking status, and seasonality. Methods We analyzed sensing technology based spirometry data from refractory asthmatics whose mean FEV1/FVC ratio is lower than < 80%, lived in Seoul or Kyunggi Province, South Korea , and attended hospital between 2016 and 2017 with multiple exacerbations. We constructed mixed model using the data clustered within each patient. Results We analysed 1100 episodes data relating to 25 never-smoking patients. After adjusting for sex, age, body mass index (BMI), and total IgE level, a unit increase in concentration of particles  $\leq 2.5 \mu\text{m}$  (PM2.5), or CO2 concentration on Lag 0, reduced the FEV1/FVC ratio by 0.1% (95% confidence interval [CI]: 0.0–0.4%). Patients living in house with high damp scores (3 and 4) showed lower ratio than the others (1 and 2). Conclusions This study demonstrated that reduction in pulmonary function in adult asthma patients were potentially associated with acute exposure to increased indoor PM2.5, CO2 and damp levels with irrespective to total IgE level.

**P02.1330. Air Pollution Exposures and Risk of High Blood Pressure in Diabetes Mellitus Patients, China: A Retrospective Cohort Study**

Kun Chen

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**Abstract:** Background: Air pollution exposures have been associated with hypertension, but limited studies have examined the associations in diabetes mellitus patients. Objectives: We aimed to examine the associations of exposure to air pollution with risk of hypertension in diabetes mellitus patients. Methods: We identified hypertension cases from hospital records among patients who were previously diagnosed as diabetes mellitus from January 2013 to May 2017. We used generalized additional models to estimate adverse effects of air pollution on systolic/diastolic blood pressure in diabetes patients. Results: A total of 2,050 patients were enrolled in this study. A 10 $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, and O<sub>3</sub> exposure was associated with an increased risk of higher systolic blood pressure [D1] level (risk ratio (RR) =1.001; 95% confidence interval (CI):1.000, 1.002; RR =1.001; 95%CI: 1.000, 1.002; RR =1.004; 95%CI: 1.001, 1.006). Significant associations were observed with fasting blood glucose (fbg)  $\geq 7.0$  mmol/L, overweight/ obesity, and younger age. Little evidence has been observed for the associations between particulate matter (PM), SO<sub>2</sub> and O<sub>3</sub> exposure and diastolic blood pressure in present study. Conclusions: In our study, diabetes patients were at increased risk for higher blood pressure when exposed to higher residential PM and SO<sub>2</sub>. Individuals with higher BMI, younger age, and FBG  $\geq 7.0$  mmol/L were more susceptible to ambient air pollution.

**P02.1331. Size-Fractionated Particle Number, Length, and Surface Area Concentrations and Daily Mortality in Augsburg, Germany, 2004-2009**

Kai Chen

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**Abstract:** Background: Although epidemiological studies have shown positive associations between ultrafine particles (UFP) and daily mortality, evidence on different particle metrics and size fractions is lacking. Objectives: We explored the associations of daily mortality with short-term exposure to size-fractionated particles measured in number, length, and surface area concentrations in Augsburg, Germany. Methods: We collected daily data on total natural mortality, size-fractionated particle number concentration (PNC), length concentration (PLC), and surface area concentration (PSC) (10-1000 nm) during November 2004 to December 2009. We further collected daily PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, and O<sub>3</sub>. We estimated associations between particles and mortality using Poisson generalized additive models with over-dispersion, while accounting for ambient temperature, long-term and seasonal trend, day of the week, influenza epidemics, and population dynamics due to summer vacation and holiday. Results: We found positive and delayed (lag 6) associations between particles 10-500 nm and daily mortality in all three metrics. For example, an interquartile range increase in PNC<sub>10-30</sub>, PNC<sub>30-50</sub>, PNC<sub>50-100</sub>, and PNC<sub>100-500</sub> was associated with 2.53% (95% CI: 0.04, 5.09%), 1.91% (95% CI: -0.14, 4.01%), 1.88% (95% CI: -0.17, 3.97%), and 1.86% (95% CI: -0.19, 3.96%) increase in total natural mortality. The corresponding estimates for UFP (10-100 nm) and PNC<sub>10-500</sub> were 2.16% (95% CI: 0.02, 4.00) and 2.26% (0.06, 4.50), respectively. Using PLC or PSC metrics yielded weaker and nonsignificant estimates. No associations with natural mortality were found for particles 500-1000 nm. Associations between size-fractionated PNC, PLC, and PSC remained similar after adjustment for mass concentrations of PM and gaseous pollutants. Conclusions: Size-fractionated PNC within 10-500 nm were associated with natural mortality in Augsburg, whereas no associations were observed for particles within 500-1000 nm (mainly secondary aerosol).

**P02.1340. Implications of Exposure Measurement Error for Interpreting Epidemiological Results for Studies of Exposure to PM, NO<sub>2</sub>, or SO<sub>2</sub>: Effect of Error Type on Bias and Coverage Probability**

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Abstract: In epidemiologic studies of health effects of air pollutant exposure, measurements or models are used to estimate exposure concentration. These estimates have some errors that propagate to health effect estimates in exposure-response models. We critically evaluate effect of exposure error type on bias and coverage probability (CP) to understand conditions affecting interpretation of exposure-response models. We evaluate differences in bias and CP from exposure error for epidemiologic studies of exposure to PM<sub>2.5</sub>, NO<sub>2</sub>, and SO<sub>2</sub>. We review available literature on exposure error for short-term and long-term exposure studies. For short-term exposure studies, temporal confounding (temporal factors such as season influence both exposure and health outcome) decreases CP and increases positive bias, implying the true health effect is larger than predicted and model uncertainty grows with increasing bias. Population error (single daily exposure concentration does not account for variation in exposure due to time-activity during a day) and nonambient (indoor) sources bias the health effect estimate towards the null and decreases CP, so uncertainty grows with increasing bias while underestimating the true health effect. Spatial error (deviation between true exposure concentration at an individual's location and concentration at a receptor) was relatively unbiased but in some instances resulted in lower CP. For long-term exposure studies, spatial confounding (spatial factors such as residential location influence both exposure and health outcome) produced positive bias with lower magnitude than for short-term exposure studies. Most spatial errors did not bias the health effect estimate. In both cases, large uncertainties were observed when exposure concentration was modeled with low spatial and temporal resolution for a spatially-variable pollutant. Views expressed in this abstract are of the authors and do not necessarily reflect views or policies of the U.S. EPA.

**P02.1350. Maternal Exposure to Ozone and PM2.5 and the Prevalence of Orofacial Clefts in Four U.S. States**

Ying Zhou

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**Abstract:** Background: While there is some evidence that maternal exposure to ambient air pollution is associated with orofacial clefts in offspring, the epidemiologic studies have been largely equivocal. We evaluated whether maternal exposure to elevated county-level ambient fine particulate matter with aerodynamic diameter  $\leq 2.5 \mu\text{m}$  (PM2.5) and ozone during early gestation was associated with a higher prevalence of orofacial clefts. Methods: Birth data consisting of 4.7 million births from 2001-2007 were obtained from National Birth Defects Prevention Network for four states - Arizona, Florida, New York (excluding New York City), and Texas. The air pollution exposure assessment for gestational weeks 5-10 was based on county-level average concentrations of PM2.5 and ozone data generated using a Bayesian fusion model available through CDC's Environmental Public Health Tracking Network. Two outcomes were analyzed separately: cleft lip with or without cleft palate, cleft palate alone. In logistic regression analyses, we adjusted for factors that were suspected confounders or modifiers of the association between the prevalence of orofacial clefts and air pollution, i.e., infant sex, race-ethnicity, maternal education, smoking status during pregnancy, whether this was mother's first baby, maternal age. Results: Each  $10 \mu\text{g}/\text{m}^3$  increase in PM2.5 concentration was significantly associated with cleft palate alone (OR = 1.43, 95% CI: 1.11-1.86). There was no significant association between PM2.5 concentration and cleft lip with or without cleft palate. No associations were observed between ozone exposure and the two outcomes of orofacial clefts. Conclusions: Our study suggests that PM2.5 significantly increased the risk of cleft palate alone, but did not change the incidence of cleft lip with or without palate. Ozone levels did not correlate with incidence of orofacial clefts.

## **P02.1360. Longitudinal Analysis of Particulate Air Pollutants and Executive Function in Southern California Youth**

Diana Younan

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**Abstract:** Executive function (EF) is critical for social well-being and mental/physical health. Previous studies on ambient air pollution and EF have produced mixed results, and the suggested adverse effect was largely inferred from studies only measuring sub-domains of EF in school-age children with limited follow-up. We conducted a prospective study to examine whether residential ambient air pollution affects EF from late childhood to early adulthood in urban-dwelling populations. A multi-ethnic cohort of Southern California twins/triplets (N=829) was examined in 2000-2014 (aged 9-21 years), each with repeated EF assessments of Preservative Responses (cognitive flexibility) and Nonperseverative Errors (control of attention resources and self-monitoring) from the Wisconsin Card Sorting Test (WCST), an integrated testing battery for frontal lobe damage. We estimated ozone and PM<sub>2.5</sub> using generalized additive models, NO<sub>x</sub>/NO<sub>2</sub> using land use regression models, freeway and non-freeway NO<sub>x</sub>/NO<sub>2</sub> using CALINE4 dispersion models, and elemental carbon using the UCD/CIT chemical transport model. Monthly exposure time-series were aggregated to derive 1-, 2-, and 3-year averages preceding each EF assessment. Multilevel mixed-effects models were used to estimate the exposure effects on continuous standard scores of EF. Long-term PM<sub>2.5</sub> (range of IQRs: 4.86-5.25 µg/m<sup>3</sup>) was significantly (all p<0.05) associated with poorer performance in both WCST measures, with effect sizes equivalent to 4.5-7 years of delay in EF development, adjusting for potential confounders (sociodemographics; neighborhood quality and socioeconomic characteristics; other pollutants; spatial covariates; maternal and early-life risk factors). No consistent associations were found with other exposure measures. These results provide strong evidence that long-term PM<sub>2.5</sub> exposure contributes to reduced EF, suggesting that the frontal lobe may represent a brain region most vulnerable to air pollution neurotoxicity.

## **P02.1380. Evaluate the Validity of Land Use Regression Models for NO<sub>2</sub> Based on Routine and Campaign Monitoring Data from an Urban Area of Japan**

Saori Kashima

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**Abstract:** Background: Generally, land use regression (LUR) models have been built using campaign monitoring data rather than routine monitoring data. However, the routine monitoring data have advantages such as low cost and long-term coverage. The objective of this study was to compare the predictability of LUR models for NO<sub>2</sub> based on routine and campaign monitoring data obtained from an urban area. This evaluation considered that LUR models that could represent regional differences in air pollution exposure and regional road structure were optimal. Method: We selected the city of Suita in Osaka (Japan). We built a model based on routine monitoring data obtained from all sites (routine-LUR), and a model based on campaign monitoring data (campaign-LUR) within the city. The routine LUR models were based on monitoring networks across two prefectures (i.e., Osaka and Hyogo prefectures). Next, we selected 30 evaluation sites and developed LUR models excluding these evaluation sites. We calculated the predictability of each model, and compared the predicted NO<sub>2</sub> concentrations from each model with measured annual average NO<sub>2</sub> concentrations from evaluation sites. Results: The predictability for NO<sub>2</sub> concentrations of routine-LUR model was better than that of campaign-LUR model: Adjusted R<sup>2</sup> = 0.68 and 0.59, respectively, and root mean square error = 3.4 ppb and 3.9 ppb, respectively. The routine-LUR model were highly correlated with the measured NO<sub>2</sub> concentrations at evaluation sites [ $\rho = 0.88$ ] comparing with the campaign-LUR model [ $\rho = 0.54$ ]. Although the predicted NO<sub>2</sub> concentrations from each model were correlated, the LUR models based on routine networks provided better visual representations of the local road conditions in the city. Conclusion: The present study demonstrated that LUR models based on routine data could estimate local traffic-related air pollution in an urban area. The importance and usefulness of data from routine monitoring networks should be acknowledged.

## **P02.1390. Social Susceptibility to Multiple Air Pollutants in Cardiovascular Disease**

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Abstract: Cardiovascular disease (CVD), the leading cause of death in the U.S., has been linked to chronic and acute air pollution exposures. Research has identified stronger effects of air pollution in lower-socioeconomic position (SEP) communities, where exposures are also often higher. While specific factors leading to this susceptibility remain unknown, chronic psychosocial stress related to social adversity has been hypothesized as a critical component. In this study, we aim to examine associations between air pollution exposures and CVD events using a case-crossover design, and assess effect modification of these associations by community SEP and/ or specific chronic stressor exposures (e.g., crime, deprivation). We quantify relationships between exposures and CVD events in NYC using four unique datasets: [1] Spatial data on citywide community SEP and stressor indicators; [2] Surfaces for fine-scale spatial variation in multiple pollutants from NYC Community Air Survey [fine particles (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), summertime ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>)]; [3] Daily ambient pollution concentrations from EPA AQS monitors; [4] Complete data on in- and out-patient unscheduled CVD events presented in NYC emergency departments (ED) 2005-2011 (n = 1.3 million), from NY State Department of Health Statewide Planning and Research Cooperative System. In preliminary analyses, we observed 1.0 to 3.5% increases in excess risk of CVD ED visits - for both overall CVD risk and key sub-diagnoses (e.g., acute myocardial infarction, stroke) with a 10-ppb increase in ozone exposure on lag days 0-1. Associations with CVD for ozone on lag days 2-6 days were not significant. We have found suggestive evidence of effect modification by SEP and stressors including violent crime; we found the lowest excess risk of a CVD event in communities in the lowest-crime quartile (e.g., 0.9% excess risk on lag day 0), and increasing risks with increasing crime (e.g., 3.1% excess risk on lag day 1).

## **P02.1400. Air Pollution and Childhood Autism Spectrum Disorder in Taiwan**

How-Ran Guo

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**Abstract:** Air pollutants have been linked to some diseases in human, including those of the respiratory and cardiovascular systems. However, their effects on the nervous system were less frequently evaluated. Autism Spectrum Disorders (ASD) is a group of neurodevelopmental disorders of which the etiology is still unknown. We conducted a study in Taiwan to evaluate the possible associations between exposure to air pollutants and ASD. From the one million people in the Taiwan National Insurance Research Database, which is a random sample of the general population, we identified all the infants born between 1996 and 2000. We followed them till the end of 2013 and identified cases of ASD. We traced back the mother's residence and assess the exposure to air pollutants using the data obtained from the air quality monitoring database maintained by the government, which included ozone (O<sub>3</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and particles with diameter less than 10 μm (PM<sub>10</sub>). The effects of the exposures in five different periods were evaluated, including the three trimesters, the whole gestation, and the month right after birth. Cox proportional hazard models were constructed to evaluate the associations between pollutants and childhood ASD. We indentified a total of 29,282 newborns. After adjusting for other risk factors, an increase of 10 ppb of NO<sub>2</sub> was associated with a hazard ratio (HR) of 1.19 (95% confidence interval [CI]: 1.03-1.37) for developing ASD in the first trimester and an HR of 1.15 (95%CI: 1.01-1.33) in the second trimester. A 1 μg/m<sup>3</sup> increase in PM<sub>10</sub> was associated with an adjusted HR of 0.99 (95%CI: 0.98-0.99) in the month of birth and an adjusted HR of 0.99 (95%CI: 0.98-0.99) in the third trimester. In conclusion, we found that exposure to NO<sub>2</sub> in the first two trimesters was associated with an increased risk of developing childhood ASD, but exposure to PM<sub>10</sub> was not.

## **P02.1410. Ambient Air Pollution and the Risk of Stroke and Atrial Fibrillation: A Population-Based Cohort Study**

Saeha Shin

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**Abstract:** Background: Atrial fibrillation (AF) is the leading arrhythmia and a major risk factor for stroke. There is growing evidence linking air pollution to stroke incidence, but less is known for AF. We assessed the association between air pollution, first-ever hospitalization for stroke, and newly diagnosed cases of AF. We also sought to characterize the shape of air pollutant-disease relationships. Methods: We assembled a population-based cohort of 5,071,956 long-term Ontario residents, who were aged 35-85 years and free of stroke and AF on 1 January 2001. Incidence of stroke and AF were ascertained using validated algorithms and health administrative databases. For subjects' residential postal codes, we estimated 5-year mean concentrations of fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and ozone (O<sub>3</sub>) from satellite-derived data, land-use regression models, and fusion-based methods, respectively, and the redox-weighted average of NO<sub>2</sub> and O<sub>3</sub> (Ox). Using Cox proportional hazards models, we estimated the associations between air pollutants, stroke, and AF, adjusting for individual- and neighborhood-level characteristics. We used newly developed non-linear risk models to characterize the shape of pollutant-disease relationships. Results: During the 14-year follow-up, we found 122,545 incident strokes and 313,157 incident AF cases. Each interquartile range increment of PM<sub>2.5</sub>, NO<sub>2</sub>, O<sub>3</sub>, and Ox was associated with increased risk of stroke [HRs (95% CIs) of 1.05 (1.03-1.07), 1.04 (1.01-1.06), 1.05 (1.03-1.06), and 1.05 (1.04-1.06), respectively]. Air pollution exposure was associated with 1% to 3% increased risk of AF. Associations remained after additional adjustments (e.g., comorbidities and spatial random effects Cox models). In pollutant-disease relationships, stroke was found to be near linear for PM<sub>2.5</sub> and sublinear for Ox. For AF, the shapes were both sublinear for PM<sub>2.5</sub> and Ox. Conclusions: Air pollution exposure was associated with stroke and AF onset.

## **P02.1420. Comparison of Different Hybrid Modeling Methods for the Estimation of Intraurban Air Pollutant Concentrations**

Inbo Oh

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**Abstract:** Exposure to air pollution - a major potential environmental factor - can exert significant health effects on the urban population. The improvement of modeling methods to estimate the concentrations of air pollutants within a complex city should be important for exposure assessment of subjects in health studies. This paper presents several hybrid modeling approaches to simulate highly resolved variability in ambient air pollution in the capital of South Korea, Seoul. They combine the Community Multiscale Quality (CMAQ), a regional photochemical model with fine scale models including the California Puff (CALPUFF) dispersion model and the land use regression (LUR) model. We compared the high-resolution spatial pollutant concentration estimates from four different hybrid combinations: 1) raw CMAQ-CALPUFF; 2) observation-fused CMAQ-CALPUFF; 3) raw CMAQ-LUR; 4) observation-fused CMAQ-LUR. We quantitatively evaluated the simulated concentrations with field data from mobile measurements carried out during the winter season. The results showed that significant differences in sub-grid variability of pollutant concentrations were found according to different hybrid modeling methods and observation-fused hybrid modeling can generally improve the model performance in a complex urban area. Our study suggests that a properly evaluated hybrid modeling approach could increase the accuracy of air pollutant concentration estimates for the purpose of improving exposure assessment in a health study.

## **P02.1440. Land Use Regression Modelling: An Air Pollution Monitor Location Optimization Approach**

Matthew Adams

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Abstract: Land use regression (LUR) modelling associates measured pollution levels to land cover characteristics for spatial interpolation. LUR is commonly applied in the domain of air pollution and less commonly for noise, soil and water pollution. Model outputs can be applied to estimate human or environmental exposure. The model's predictor variables include land use attributes, such as land cover and transportation network characteristics that are calculated within spatial buffers of the monitoring locations. LUR models can be used to predict values at unobserved locations. The application of spatial interpolation attempts to ensure that data are not extrapolated beyond the bounds of the observed values. However, our research identifies that without guaranteeing monitoring data be collected in all land use classes and conditions, it is possible with LUR to actually be extrapolating data and still be within the 2-dimensional spatial boundaries of the monitoring locations. This potential extrapolation occurs because the interpolation is based on a multi-dimensional space that sits upon the 2-D plane, which creates a new set of boundaries for the interpolation. In this paper, we define and demonstrate the potential problem of ensuring LUR models interpolate within both the 2-D spatial domain and the multi-dimensional space that is applied in LUR modelling. We then demonstrate a solution to this problem in a simulated dataset and in an empirical dataset. First, we identify all possible monitoring locations. Second, the objective function is defined with the goal of selecting monitoring locations to maximize the variation across land use conditions. A heuristic search technique is applied to identify good potential solutions. The location of monitors is identified using an ensemble of potential optimum solutions.

## **P02.1450. All-Cause Mortality Risks Associated with Long-Term Exposure to Ambient Fine Particulate Matter in the Chinese Healthy Longevity Cohort**

Tiantian Li

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**Abstract:** There is extensive evidence from cohort studies in North America and Europe for increased mortality risk from long-term exposure to fine particulate matter (PM<sub>2.5</sub>). However, this association has rarely been quantified at higher ambient concentrations. We sought to estimate the hazard ratio (HR) for all-cause mortality from long-term exposures to PM<sub>2.5</sub> exposure in a well-defined Chinese cohort of older adults. The Chinese Longitudinal Healthy Longevity Survey (CLHLS) study is a prospective cohort study of elderly men and women enrolled in 2008 and followed through 2014 for mortality events. We studied 13,344 subjects for whom residential locations during the follow-up period were available for linkage to 1 km gridded PM<sub>2.5</sub> concentrations, derived from ground-based measurements and satellite remote sensing. The outcome measure was all-cause mortality. Cox proportional hazards models were used to estimate the effect of long-term PM<sub>2.5</sub> concentrations on all-cause mortality, controlling for age, sex, smoking status, drinking status, physical activity, BMI, household income, marital status, education. We then applied our results to estimate PM<sub>2.5</sub>-related premature mortality for persons older than 65 years-of-age in all of China in 2010. The overall HR for a 10 mg/m<sup>3</sup> increase in 3-year average PM<sub>2.5</sub> concentration was 1.08 (95% CI: 1.06-1.09). There was strong evidence for differences in effects by urban/rural, north/south and high/low PM<sub>2.5</sub> exposure. The HR was higher in rural and southern regions, and at lower PM<sub>2.5</sub> exposure levels. The estimated total PM<sub>2.5</sub> related all-cause mortality of Chinese elderly was 1,765,820 in 2010. Long-term exposure to PM<sub>2.5</sub> was associated with an increased risk of all-cause mortality among elderly adults in China, but the magnitude of the risk declined as concentrations increased.

## **P02.1460. Estimating Concentrations of PM2.5 Species with Random Forest Algorithm across Continental United States during 2005 - 2015**

Jiaozhao Bi

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Abstract: PM2.5 is a complex mixture of chemical species, which are emitted from various emission sources; however, currently, PM2.5 is regulated and its health effects are mainly studied based on total mass concentrations. Identifying the differential toxicity of PM2.5 species should be able to provide scientific evidence for more effectively regulatory control of PM2.5 pollution. We develop national models based on random forest algorithm by incorporating land use parameters, meteorological variables and GEOS-Chem simulated concentrations of PM2.5 species to predict ground-levels of PM2.5 sulfate, nitrate, OC and EC across Continental United States from 2005 to 2015. Overall, the random forest models achieve high validation R2 values based on daily predictions, which are 0.80 - 0.90 for sulfate and nitrate, and 0.70 - 0.80 for OC and EC during the study period. With the help of importance rankings of random forest algorithm, our modeling method is able to figure out unique combinations of potential significant contributors among large number of predictors for predicting different PM2.5 species. The long-term temporal trends of predictions of PM2.5 sulfate, nitrate, OC and EC match well with their corresponding ground measurements. The prediction maps capture both regional patterns and hotspots of the four PM2.5 species. Therefore, our national models could provide exposure assessment with high spatial and temporal flexibility for epidemiological studies to better understand the acute and chronic toxicity of PM2.5 speciation across locations in Continental United States.

## **P02.1470. Spatiotemporal Modeling of Oxidative Potential of Ambient Particulate Matter Using Chemical Transport Model-Derived Emission Sources**

Armistead Russell

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Abstract: Multiple epidemiologic studies have found associations between the oxidative potential (OP) of fine particulate matter (PM<sub>2.5</sub>) and adverse cardiorespiratory outcomes, supporting the hypothesis that PM may be capable of inducing oxidative stress. However, limited observational data on OP restrict the scope of exposure and epidemiologic analyses. Here, an advanced PM<sub>2.5</sub> emission source impact analysis is used with limited OP observations to develop and apply a model capable of simulating daily OP over a wide spatial domain, specifically across the eastern United States. OP of ambient water-soluble PM<sub>2.5</sub> was measured using an acellular dithiothreitol (DTT) assay at four locations across the southeastern United States from June 2012-July 2013. PM<sub>2.5</sub> source apportionment was performed during the same time period across the eastern United States using CMAQ-DDM with advanced data assimilation techniques to minimize biases. These sources were related to ambient OP measurements using multivariate linear regression with backward selection. The resulting model was applied to estimate spatio-temporal trends in ambient OP across the eastern United States. Regression analyses show that vehicles and fires significantly contribute to OP, supporting previous findings. Higher OP is generally seen in the winter than the summer and in urban areas compared to rural areas. The intraurban spatial distribution driven by vehicle impacts was briefly investigated, showing a high spatial correlation with RLINE modeled primary roadway concentrations. The CMAQ-DDM modeling approach may be useful for health studies utilizing exposure data across a large study domain (e.g. multiple cities), can integrate a broad range of OP measurements, and can help to identify sources of PM with high OP for regulatory purposes. While this work was supported in part by a grant from the US EPA, this abstract does not necessarily reflect EPA policy.

## **P02.1490. The Contribution of Residential Coal Combustion to the Oxidative Potential of Atmospheric Fine Particulate Matter in Beijing, China**

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Abstract: Human exposure to atmospheric fine particulate matter (PM<sub>2.5</sub>) is associated with various health effects such as respiratory and cardiovascular diseases. The adverse effects of inhaled PM<sub>2.5</sub> has been demonstrated to have a strong link with cellular oxidative stress through generation of reactive oxygen species (ROS). Recent studies show that residential coal combustion has significant contribution to ambient PM<sub>2.5</sub> in winter in the Northern China due to its low temperature and incomplete combustion conditions. Moreover, coal combustion is the major source of metals and quinones in the atmosphere in Beijing, which could induce the formation of ROS. To address the oxidative potential of PM<sub>2.5</sub> from residential coal combustion and its contribution to ambient PM<sub>2.5</sub> in Beijing, PM<sub>2.5</sub> samples were collected from residential coal combustion from source tests in the laboratory and at an ambient urban site in Beijing during fall and winter, 2014. Organic carbon (OC), elemental carbon (EC), soluble ions and trace metals were analyzed. The amount of hydroxyl radical (OH) generated by collected PM, which is the most reactive ROS species, was also measured in an aqueous buffered extract solution as a surrogate lung fluid (SLF). Our preliminary results showed that OH production per unit PM mass (ng/Kg PM) from chunk coal was lower than that from honeycomb coal. However, the total OH production by PM from burning one Kg honeycomb coal (ng/Kg coal) was much higher than that from chunk coal, due to higher emission factor of PM from honeycomb coal. The results of receptor-based source apportionment showed that coal combustion and vehicle exhaust were the major sources contributing to PM oxidative potential in fall and winter in Beijing. As PM<sub>2.5</sub> concentration increased, the contributions of coal combustion and industry source also increased.

## **P02.1500. Low Vitamin D Levels Are Associated with Elevated Cardiovascular Responses after a Controlled Diesel Exhaust Exposure in Healthy Human Subjects**

Jaime Mirowsky

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Abstract: Cardiovascular disease accounts for over 17 million deaths per year. There is a large body of evidence suggesting that vitamin D deficiency is associated with cardiovascular disease and disease risk factors. In addition, researchers have found that exposures to ambient air pollution - particularly particulate matter (PM) - represent an added and independent risk factor for cardiovascular morbidity and mortality. Therefore, we wanted to assess whether vitamin D levels are associated with a heightened adverse cardiovascular response to diesel exhaust in healthy human subjects. Using a randomized, crossover study design, 13 healthy, young adults were exposed on two separate occasions to 300 µg/m<sup>3</sup> diesel exhaust and filtered air under controlled conditions. Before, after, and 18 hrs following each exposure, blood samples were collected. The average vitamin D concentration before clean air exposures was 22.3 ng/mL, and the average vitamin D concentration before diesel exposures was 23.4 ng/mL (paired t-test; p = 0.44). Four participants were considered vitamin D deficient (vitamin D < 20 ng/mL), 7 participants had inadequate vitamin D levels (vitamin D between 21-29 ng/mL), and 2 were vitamin D sufficient (vitamin D > 30 ng/mL). Positive and significant associations were observed between baseline vitamin D concentrations and tPA ( $\beta = 6.93$ , 95% CI = -0.30, 13.57), while a negative and significant association was found with plasminogen ( $\beta = -2.84$ , 95% CI = -5.07, 0.61). At 0 hrs post exposure, there were significant negative associations between baseline vitamin D concentrations and D-dimer ( $\beta = 0.02$ , 95% CI = -0.04, 0.00) and IL-8 ( $\beta = -0.03$ , 95% CI = -0.06, 0.00). Additionally, at 18 hrs post exposure negative associations were found between baseline vitamin D concentrations and PAI-1 ( $\beta = -0.03$ , 95% CI = -0.07, 0.01) and TNF- $\alpha$  ( $\beta = -0.03$ , 95% CI = -0.06, 0.00). This suggests vitamin D deficiency might be associated with elevated cardiovascular responses.

## **P02.1510. Household Energy and Health in India: A Situational Assessment and Stakeholder Mapping**

Bhargav Krishna

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**Abstract:** Background: Air pollution is a major and growing risk factor, contributing significantly to India's burden of disease. While there is a growing recognition that access to clean household energy for lighting, heating and cooking is pivotal for improving health, socio-economic conditions and environmental protection, over 60% of rural Indians are caught in the 'chulha trap', reliant on solid fuels like wood or dung for cooking and heating. Several initiatives have been undertaken across various government departments over the years to address household air pollution ranging from provision of cleaner chulhas to LPG connections. Methods: In this study, we undertook a stakeholder mapping exercise to understand the landscape of household energy and health interventions in India. In doing so, we document historical and current policies related to household air pollution (HAP) and its health impacts undertaken by the central and two state governments (Rajasthan and Maharashtra). We also collected secondary data on interventions and held discussions with stakeholders from the government, private sector and civil society to understand perceptions around health impacts of HAP, role of environmental health in policy development and decision-making, and factors associated with implementation of programmes on household energy and health. Conclusions: Through this study, we identify the challenges in implementation and the importance of introducing behaviour change and awareness campaigns of health impacts of HAP, without which existing interventions may not succeed. We also recognize the need to reform governance structures by enabling inter-ministerial dialogue and coordination, strengthening regulatory mechanisms, monitoring and evaluation of interventions as a means of continuous learning and placing health centrally in decision-making related to household energy and health in India.

## **P02.1511. Review of the Acute Effects of the Daily Exposure to Particulate Matter on Lung Function and Lung Inflammation in Healthy Subjects**

Alan da Silveira Fleck

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**Abstract:** The effects of daily exposure of particles in ambient air on acute respiratory outcomes have shown inconsistent results, and no meta-analysis about this topic has been performed. We aimed to review studies on the association between the daily exposure to particles in ambient air and in occupational settings, and their acute effects on lung function and lung inflammation of healthy adults. Original studies published between 2000 and 2017 were searched in Web of Science, Medline and Pubmed. Studies were included if they assessed exposure to particles (number or mass concentration), and measured at least one spirometric parameter or fractional exhaled nitric oxide (FeNO). Studies were excluded if respiratory outcomes were not measured within 24 hours after exposure, if there was no baseline for health outcomes or if the study population was not composed of healthy adults. 2447 studies were considered, and 239 studies were retained after the first screening (title + abstract). The final selection included 51 environmental (27 cross-over, 20 panel and 4 cross-sectional studies) and 34 occupational studies (27 cross-shift, 5 cross-over and 2 panel studies). The most frequent fractions of particulate matter assessed were PM<sub>2.5</sub> (41), PM<sub>10</sub> (20) and UFP (19). 31 studies evaluated FeNO, while 70 studies included spirometric measures (FEV<sub>1</sub> (63), FVC (48), PEF (32) and FEV<sub>1</sub>/FVC (20) were the most frequent). Population (i.e. age) and exposure characteristics (i.e. duration, composition, type of monitoring, exposure levels) varied greatly between studies. There was also a large variability in the associations observed. Future studies should assess factors that explain such variability.

## **P02.1520. Integrating Spatiotemporal Variability and Modifiable Factors into Air Pollution Estimates**

Naomi Zimmerman

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**Abstract:** City-wide air pollution measurements have typically relied on a small number of widely separated regulatory monitoring sites or land use regression (LUR) maps built using time-integrated samples to assess population-scale exposure. However, air pollutant concentrations may exhibit significant spatial and temporal variability depending on local sources and features of the built environment, which are poorly captured by the existing monitoring regime. To better understand urban spatiotemporal pollution gradients on the <1 km scale, 15 fixed air quality monitoring stations were deployed in Pittsburgh, PA from August 2016-May 2017; this was complemented with mobile sampling in ~1 km<sup>2</sup> grids around the fixed stations. The fixed stations were deployed at locations with a range of traffic, restaurant and population densities. The fixed stations included measurements of ultrafine particle number (UFP), PM<sub>2.5</sub>, and a low-cost air quality monitor, the Real-time Affordable Multi-Pollutant (RAMP) sensor package for measuring CO, NO<sub>2</sub>, O<sub>3</sub>, and CO<sub>2</sub>. Pollutant time series from the fixed stations were deconvolved using wavelet decomposition to separate short-lived (<2h) pollution events from partial-day events (2-8h) and persistent enhancements (baseline changes >8h) above the regional background. The combined short-lived (<2h) and persistent enhancement pollutant signals are hypothesized to represent the 'local' pollutant characteristics of a site. Compared to the total pollutant signal, the average local and persistent enhancement pollutant signals were better correlated with modifiable factors typically used as covariates in land-use regression building. The findings support building more accurate and time-resolved LURs, which may be more transferable to other domains by isolating the truly 'local' pollutant signal. These improved LURs will enable better air pollutant exposure estimates and aid in the identification of environmental policy priorities towards improved air quality.

## **P02.1530. Ambient Particulate Matter and Cardiovascular Incidence in a Nationwide Cohort in South Korea**

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**Abstract:** While ambient particulate matter (PM) was suggested as a risk factor for cardiovascular disease (CVD) in North American and European cohort studies, some studies in other countries reported weak or negative associations. We aimed to investigate the association between chronic exposure to PM with a diameter less than 10  $\mu\text{m}$  (PM<sub>10</sub>) and incident CVD and to identify susceptible population using a national cohort in South Korea. Our study population included 142,028 adults in the National Health Insurance Service-National Sample Cohort who were more than 30 years old, underwent health examination, and had not diagnosed with CVD for 2002-2006. The incident CVD was defined as the first hospital visit for 2007-2013, based on the International Classification Diseases, 10th revision. The chronic PM<sub>10</sub> exposure for each person was computed as the 5-year average for 2002-2006 using residential district-level annual mean concentrations predicted by a previously-developed exposure prediction approach. Cox proportional hazard models were applied for estimating hazard ratios (HR) and 95% confidence intervals (CI) of incident CVD per 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>10</sub> after adjusting for individual- and area-level risk factors. In addition, we examined the effect medication by sex, age groups (<65 or others), income (<20%), type of health insurance (employee insured), smoking (current, past, or never smoker), obesity, and disease status of hypertension, hyperlipidemia, and diabetes. The 59,791 people had a first diagnosis during 262,031,184 person-year. We did not find the association between PM<sub>10</sub> and incident CVD for all population [HR=0.99 (95% CI=0.98, 1.01)]. In the subgroup analysis, there was a significant difference by age groups with a positive association in the elderly [1.06 (1.00, 1.12)]. This study, as the first nationwide cohort study of air pollution and morbidity in South Korea, provides an evidence of higher risk of incident CVD for chronic exposure to PM<sub>10</sub> in elderly people.

**P02.1550. Fine Particulate Matter and Medications Dispensed during and after a Brown Coal Mine Fire: A Time Series Analysis**

Yuming Guo

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**Abstract:** Background: Very few studies have examined the impacts of coal mine fire smoke on human health. The aim of this study was to assess the association between prolonged mine fire smoke PM<sub>2.5</sub> exposure from a coal mine fire that burned over a six week period in 2014 and medications dispensed across five localities in South-eastern Victoria, Australia. Maximum hourly mine fire-related PM<sub>2.5</sub> concentrations were estimated to reach 3700 µg/m<sup>3</sup>. Methods: Spatially resolved PM<sub>2.5</sub> concentrations were retrospectively modelled using The Air Pollution Model, a dispersion model coupled with a chemical transport model (TAPM-CTM). Data on medications dispensed were collected from the Pharmaceutical Benefits Schedule database for 2013-2016. Poisson distributed lag time series analysis was used to examine associations between daily mine fire-related PM<sub>2.5</sub> concentrations and daily counts of medications dispensed for respiratory, cardiovascular and mental health conditions. Confounding variables included: seasonality, long-term trend, day of the week, maximum ambient temperature and public holidays. Results: Positive associations were found between mine fire-related PM<sub>2.5</sub> and increased risks of medications dispensed for respiratory, cardiovascular and mental health conditions, after lag 2-5 days. A 10 µg/m<sup>3</sup> increase in coal mine fire-related PM<sub>2.5</sub> was associated with a 15% (95%CI 8-23%) increase in respiratory medications dispensed, a 12% (9-16%) increase in cardiovascular medications dispensed and a 17% (12-22%) increase in mental health medications dispensed. Conclusions: Mine fire PM<sub>2.5</sub> exposure was associated with increased medications dispensed for respiratory, cardiovascular and mental health. These findings can help to develop the public health response in the event of future mine fires.

## **P02.1580. A Study on the Key Role of Cadmium Accumulation Induced by PM2.5 Exposure in Renal Injury**

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Abstract: PM2.5 has attracted more and more attention to the damage of the kidney. PM2.5 and heavy metal cadmium both have been proved to play an important role in renal injury. However, the role of heavy metal cadmium in renal injury induced by PM2.5 exposure have not been reported. This research chose serious heavy metal pollution in industrial area and relatively clean living area, starting from the comparison of different regional differences in the cadmium content in PM2.5, through cell experiments in vitro and population studies. The results showed that the survival rate of renal tubular epithelial cells (HK2) was significantly decreased by 100  $\mu\text{g} / \text{ml}$  of PM2.5 extract in the living area, while the survival rate of renal tubular epithelial cells was significantly decreased at 50  $\mu\text{g} / \text{ml}$  of PM2.5 in industrial area. The results showed that the nephrotoxicity of PM2.5 in industrial area was greater than that in living area. The concentration of PM2.5 and total dust in industrial polluted area and clean living area were analyzed simultaneously. It was found that the concentration of PM2.5 in industrial polluted area was significantly higher than that in living area control group. The contents of some heavy metals (manganese, mercury, cadmium) were significantly higher than those in the control group. The contents of heavy metals in blood or urine of 168 residents (excluding occupational exposure to heavy metals and nephropathy) were measured. It was found that the concentration of urinary cadmium in the observation group was significantly higher than that in the control group, but there was no significant difference in the contents of other heavy metals (blood lead, urine manganese, urine mercury, urinary arsenic) between the two groups. It was found that the concentration of cadmium and metallothionein (MT) was positively correlated with the indexes of renal injury, which reflected the key role of cadmium accumulation induced by PM2.5 in renal injury.

## **P02.1590. Exposure to Ambient Ultrafine Particles and Nitrogen Dioxide and Incident Acute Myocardial Infarction and Congestive Heart Failure: A Population-Based Cohort Study**

Li Bai

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**Abstract:** Background. Although long-term exposure to traffic-related air pollutants such as nitrogen dioxide (NO<sub>2</sub>) has been linked to cardiovascular mortality and morbidity, little is known about the effect of ultrafine particles ( $\leq 0.1\mu\text{m}$  in diameter; UFPs) on the incidence of major cardiovascular events. We conducted a population-based cohort study to assess the associations of chronic exposure to UFPs and NO<sub>2</sub> with the incidence of acute myocardial infarction (AMI) and congestive heart failure (CHF). Methods. We used the Ontario Population Health and Environment Cohort (ONPHEC) to assemble our study cohorts which comprised all long-term Ontario residents who were aged 30 to 100 years and free of respective study outcomes, and lived in the City of Toronto, Canada on January 1st, 1996. Subjects were followed until December 31st, 2012. Outcomes were ascertained using validated province-wide databases. We estimated annual concentrations of UFPs and NO<sub>2</sub> using land-use regression models and assigned these estimates to participants' annual postal-code addresses during the follow-up period. Using random-effects Cox proportional hazards models, we calculated hazard ratios (HRs) and 95% confidence intervals (CIs) for UFPs and NO<sub>2</sub>, adjusted for individual- and neighborhood-level covariates. We considered both single- and multi-pollutant models. Results. Between 1996 and 2012, we identified 106,644 and 43,745 incident cases of AMI and CHF, respectively. Each interquartile change in exposure to UFPs ( $\sim 10,000$  count/cm<sup>3</sup>) was associated with increased risk of incident AMI (HR=1.05; 1.02-1.07) and CHF (HR=1.03; 1.02-1.05) after adjusting for all covariates. These results remained unaltered with further control for fine particulate matter (PM<sub>2.5</sub>) and NO<sub>2</sub>. Exposure to NO<sub>2</sub> was also independently associated with higher incidence of CHF. Conclusion. Exposure to traffic-related air pollution including UFPs and NO<sub>2</sub> may increase the risk of incident cardiovascular events.

**P02.1600. What Explains LPG Adoption? Role of Culture, Women's Empowerment, and Economics, Using the Indian Human Development Survey, 2005 and 2012**

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**Abstract:** INTRODUCTION According to the Global Burden of Disease study, household air pollution from cooking with solid fuels killed over 700,000 Indians in 2016. Major national initiatives aim to combat the problem via increased distribution of connections to subsidized Liquefied Petroleum Gas (LPG). Here, we examine the relationship between LPG adoption / disadoption and household factors. METHODS We used the 2005 and 2012 Indian Human Development Survey (IHDS), a nationally representative multi-topic panel dataset (re-contact rate: 84%). Using linear regressions, we estimated associations between LPG adoption/disadoption and (1) household economic status (income, assets, and consumption) and (2) cultural factors, including women's empowerment. We developed a gender / women's empowerment score based on questions on independence, family dynamics and decision making, and a binary variable for whether men eat first in the family. RESULTS Of the 12926 households (HH) who owned LPG in 2005, 1181 (9%) gave up LPG in 2012. Of the 23226 HH who did not have LPG in 2005, 5400 (23%) acquired LPG in 2012. We found significant association of economic and cultural factors with (1) LPG ownership in 2005, (2) LPG ownership in 2012, and (3) adoption/disadoption between 2005 and 2012. For example, for HH without LPG in 2005, holding all other variables constant, the odds of the HH acquiring LPG is 32% lower for HH where men eat first than in other HH ( $p < 0.001$ ). For HH with LPG in 2005, holding all other variables constant, odds of the HH disadopting LPG is 39% higher for HH where men eat first than in other HH ( $p < 0.001$ ). CONCLUSION Women empowerment can explain some of the dynamics of adoption and disadoption of clean-cooking options, and are potentially as important or more important than economic factors.

## **P02.1610. Impact of Global Change in Sulfur Dioxide, Black Carbon and Organic Carbon on PM2.5-Related Premature Mortality and Years Life Lost**

Xerxes Seposo

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Abstract: Previous research has highlighted the importance of major atmospheric aerosols such as sulfate, through its precursor sulfur dioxide (SO<sub>2</sub>), black carbon (BC) and organic carbon (OC), and their effect on global climate regimes, specifically on their impact on particulate matter of size less than or equal to 2.5 micrometers in diameter (PM<sub>2.5</sub>). Coupled with these global climate simulations, are studies which highlight the negative effects of PM<sub>2.5</sub> on human health. Globally, national policies attempt to address the change of these major active aerosols and their impact on PM<sub>2.5</sub>, which would later on presumably have a cascading effect towards the change of health risks. This study aims to determine how the change in the global anthropogenic aerosol emissions affect health, in particular through the change in attributable mortality (AN) and years of life lost (YLL). Model for Interdisciplinary Research on Climate (MIROC), a global atmospheric general circulation model (AGCM) developed by several Japanese institutions, was used to estimate the gridded atmospheric aerosol (SO<sub>2</sub>, BC, and OC) data for 0.25 by 0.25 degrees. The gridded data were then utilized to estimate the associated cause-specific risks via an integrated exposure response function, and its consequent disease burden, in terms of AN and YLL, per WHO Regions. SEARO and WPRO regions were observed to have apparent variations in AN and YLL with respect to the change in atmospheric aerosols. If atmospheric aerosols were to be reduced, both SEARO and WPRO will have co-benefits (reduced AN) among the cerebrovascular population. On the other hand, if life expectancy were to be considered, co-benefits (reduced YLL) were apparent among acute lower respiratory infection population, for both regions. The changes in the atmospheric aerosols have varying impact on the changes in the disease burden landscape globally, which could translate to varying health-oriented aerosol mitigation policies.

**P02.1620. A Difference in Difference Approach to Estimating the Effect of PM2.5 on Mortality Rates in the Northeastern and Mid-Atlantic U.S.**

Maayan Yitshak-Sade

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**Abstract:** Background: Dozens of cohort studies have associated PM2.5 exposure with early deaths. However, few studies have used causal modeling techniques, particularly methods robust to omitted confounders. We assessed the effect of annual PM2.5 exposure on all-cause mortality rates among the Medicare population in the Northeastern and MidAtlantic states, using the difference-in-differences approach for causal modeling. Methods We obtained records of Medicare beneficiaries aged 65 years or more who reside in the Northeastern or MidAtlantic states from 2000 to 2013 and followed each participant from the year of enrollment to year of death or 2013. We estimated the causal effect of annual PM2.5 exposure on mortality rates using the difference-in-differences approach in a Poisson survival analysis. We controlled for individual confounders, for spatial differences in confounders using dummy variable for each ZIP code and for state-wide time trend as a surrogate for temporal confounders using a penalized spline of year. Results We included 112,376,805 person years from 15,401,064 people, of whom 37.4% died during the study period. The inter-quartile range (IQR) of the annual PM2.5 concentration was 3 µg/m<sup>3</sup>, the mean annual PM2.5 concentration ranged between 6.5 µg/m<sup>3</sup> and 14.5 µg/m<sup>3</sup> and over 75% were below 12 µg/m<sup>3</sup>. An IQR incremental increase in PM2.5 was associated with a 4.04% increase (95% CI 3.49%; 4.59%) in mortality rates. Conclusions Assuming no predictors changing differentially across ZIP codes over time in parallel with similar changes in PM2.5, we found a causal effect of PM2.5 on mortality incidence rate in a population with low exposure.

## **P02.1630. Metabolic and Pulmonary Health Effects of Ozone and Black Carbon Exposure in Young Adult Runners**

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Abstract: Physical activity has been shown to promote health and well-being, however, exercising in environments with high level of air pollution can increase the risk of health problems ranging from reduced exercise capacity, high blood pressure to cardio-respiratory impairments. In this crossover study, we investigated the impact of short-term exposure to black carbon (BC) and ozone on metabolic and pulmonary functions among thirty healthy young adult runners after 30-minutes run on a clean and polluted route on separate days in August 2015 in Hong Kong. Measurements of systolic and diastolic blood pressures, forced vital capacity, forced expiratory volume in 1 second, peak expiratory flow and fractional exhaled nitric oxide were collected pre- and post-run. Real-time ambient concentration of BC was measured at the route, whereas concentration of ozone was obtained from Hong Kong Environmental Protection Department air monitoring station nearest to the running routes. Our runners were on average 20 years old, with mean body mass index of 20.3 kg/m<sup>3</sup>. Air pollution concentrations were higher in the polluted route than in the clean route, with the highest difference in BC (5,397 ng/m<sup>3</sup> versus 1,340 ng/m<sup>3</sup>). In single-pollutant regression models, no significant association was found between air pollution and changes in metabolic or pulmonary biomarkers adjusting for gender, type of route, temperature and relative humidity. However, when adjusting for both BC and ozone simultaneously, an interquartile range increment in BC became statistically significantly associated with increase in systolic blood pressure (17.82; 95% CI: 2.56, 33.09) after running exercise. No significant association was found for ozone upon adjusting for BC. Our finding of BC is consistent with existing literature, while further studies with greater sample size and longer exposure time are needed to investigate the effects of ozone to metabolic/lung functions in runners.

## **P02.1640. Use of Spatial Models to Predict Ambient O<sub>3</sub> and NO<sub>x</sub> Concentrations in Tianjin, China**

Jun Wu

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**Abstract:** Nitrogen oxides (NO<sub>x</sub>) and ozone (O<sub>3</sub>) are important ambient air pollutants that have been associated with a variety of adverse health effects. In North America and Europe, land-use regression (LUR) models have been widely developed to estimate pollution concentrations at a high spatial resolution. Although these models included traffic fleet composition and/or traffic counts/density as important predictors, such information is usually unavailable in developing countries. In China, LUR has only recently been applied in limited areas. We aimed to characterize NO<sub>x</sub> and O<sub>3</sub> concentrations and develop LUR models to predict their spatial distributions using solely publicly-available data in Tianjin, a major coastal city in China that is heavily polluted by traffic and industrial emissions. Seasonal NO<sub>x</sub> and O<sub>3</sub> samples were collected at 49 locations across Tianjin. Heavy-duty vehicle counts estimated from 0.5 m x 0.5 m satellite images correlated well with field-measured counts collected at a different time, thus supporting the use of high-resolution satellite images to assess vehicle traffic. We found that concentrations of NO<sub>x</sub> were highest in winter, while the opposite pattern was observed for O<sub>3</sub>. The majority of the variance in NO<sub>x</sub> concentrations was explained by heavy vehicle traffic, tree cover, and season. For O<sub>3</sub>, the variance was mostly explained by distance to airports, distance to roads, and distance to coal plants. Measured vs. predicted NO<sub>x</sub> concentrations following model calibration showed good predictive ability for NO<sub>x</sub> (R<sup>2</sup>=0.64 with field-measured heavy-duty vehicle count; R<sup>2</sup>=0.59 with satellite-based heavy-duty vehicle count) and O<sub>3</sub> (R<sup>2</sup>=0.70) models. This study provides utility for researchers investigating air pollution in regions where field-measured vehicle traffic data are not available, as well as for policy makers and public health officials seeking to understand the sources and spatial distribution of air pollution in Tianjin.

**P02.1650. Effects of Air Pollution While Being Physically Active, the Potential for Modification: A Review of the Literature**

Stephanie DeFlorio-Barker

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Abstract: Air pollution is known to be associated with morbidity and mortality, while physical activity is consistently encouraged due to its health benefits. It is well established that exercise increases the dose of environmental pollutants that enter the lungs. However, it is not clear if the risk of this increased dose outweighs the benefits of exercise. There is a lack of consensus regarding recommendations for exercising outdoors when air pollution is high. To help understand this complex issue, we reviewed the peer-reviewed literature related to exposure to air pollution modified by physical activity separated into two areas of interest: (1) the acute impacts of air pollution while exercising, and (2) the impacts of air pollution among those who routinely engage in physical activity. This review focuses on the first area. Articles were identified through PubMed, Science Direct, ProQuest Agricultural & Environmental Science Database searches on terms encompassing air pollution and exercise/physical activity (n=334). After screening, 30 papers were included and largely occurred in North America (n=15) and Europe (n=12), while the remaining papers (n=3) occurred in either Asia, Africa, or Australia. Papers were included in the review if they contained (1) exercising in clean air, (2) exercising in polluted air, (3) rest in clean air, and (4) rest in polluted air. The ongoing review of these papers has yielded mixed results. We have identified four studies that conclude that physical activity decreases the detrimental impact of air pollution, similarly two studies found air pollution negates the beneficial effects of physical activity. However, six studies found physical activity and air pollution did not interact, while eight studies found physical activity only increases exposure to air pollutants. The remaining studies (n=10) have not met the criteria for our review. This abstract does not necessarily reflect EPA policy.

## **P02.1660. Intra-Urban Exposure to PM2.5 in Mexico City Associated with Acute Cardiovascular and Cerebrovascular Mortality from 2004-2013**

Iván Gutiérrez-Avila

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**Abstract:** Background. Limited evidence exists about short-term exposure to different intra-urban concentration levels and composition of particulate matter with aerodynamic diameter  $\leq 2.5\mu\text{m}$  (PM2.5) associated with acute cardiovascular and cerebrovascular mortality. Methods. We used an ecologic approach and Generalized Linear Mixed Models (GLMM) with Poisson regressions in order to assess daily exposure to PM2.5 associated with all cardiovascular, all cerebrovascular and ischemic heart mortality in people  $\geq 25$  and  $\geq 65$  years for each one of the sixteen boroughs of Mexico City for the period from 2004-2013. Exposure to PM2.5 was evaluated with estimates from a new hybrid spatiotemporal model using satellite measurements of Aerosol Optical Depth (AOD-PM2.5) with resolution of 1 km<sup>2</sup> from NASA for same day exposure (lag0), and average of the current and previous day (lag0-1). The high spatial resolution of this model also allowed for the daily borough-level PM2.5 mean estimates to be weighted to account for population density. Spatial heterogeneity was tested by comparing the significance of the inclusion of the random-intercepts and random-slopes terms versus only the inclusion of the random-intercept term in our GLMM. Results. Exposure to AOD-PM2.5 varied from 21.6  $\mu\text{g}/\text{m}^3$  to 26.9  $\mu\text{g}/\text{m}^3$ . A 10- $\mu\text{g}/\text{m}^3$  increase in AOD-PM2.5 was associated with all cardiovascular mortality [0.2% (95%CI:0.11-0.29) to 2.3% (95%CI:2.19-2.39), increase], all cerebrovascular mortality [0.4%(95%CI:0.05-0.69) to 2.1% (95%CI:1.79-2.49), increase] and ischemic heart disease [0.6% (95%CI:0.6-0.68) to 3.8% (95%CI:3.77-3.91)] for lag0. Cerebrovascular mortality in people  $\geq 65$  showed the strongest associations for lag0 and lag0-1. Cardiovascular mortality in people  $\geq 25$  years was the only mortality outcome showing significant spatial heterogeneity. Conclusion. Intra-urban variation in PM2.5 concentration was associated with acute cardiovascular and cerebrovascular mortality within Mexico City.

**P02.1670. The Association of Long-Term Air Pollution Exposure with Blood Pressure, Vascular Stiffness and Prevalent Hypertension: Results from Compass Cohort Participants.**

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Abstract: Long-term air pollution exposure has been reported to be associated with cardiovascular mortality and morbidity in many studies, but little is known about hypertension, vascular stiffness and blood pressure. The aim of this study is to examine the cross-sectional relationship of long-term air pollution exposure with hypertension, blood pressure and vascular stiffness in Chicago. Multiethnic Prevention And Surveillance Study (COMPASS), a cohort study investigating how lifestyle, healthcare, environment, and genetics affect health. This analysis included 3119 participants 27-94 years of age who were enrolled in Chicago from 2013-2016. Systolic and diastolic blood pressure (SBP and DBP, respectively), pulse pressure (PP), and vascular stiffness measured as brachial artery distension (BAD) were collected using the DynaPulse 2000A. The long-term exposures to particles with an aerodynamic diameter < 2.5 $\mu$ m (PM<sub>2.5</sub>) and nitrogen dioxides (NO<sub>2</sub>) for the 3-year periods prior to enrollment were estimated at residential addresses from validated spatio-temporal models. We conducted a cross-sectional analysis of associations between air pollution and SBP, DBP, PP and BAD with linear regression, and prevalent hypertension with logistic regression, adjusting for potential demographic and socioeconomic covariates. Effect modification by obesity and ethnicity will be investigated by stratified analysis. We found evidence that the increased PM<sub>2.5</sub> exposure was associated with higher SBP, PP and BAD, but not with DBP. The results were inconsistent for NO<sub>2</sub>. We are still analyzing the data and results of final models with estimated values will be reported in the conference.

**P02.1680. Effects of Air Pollution on Acute and Chronic Kidney Disease: Using the National Health Insurance Service - National Sample Cohort (NHIS-NSC) Data in Korea**

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**Abstract:** In order to prevent and manage the environmental and health hazards caused by air pollution, the preparation of the scientific evidenced data is very important. However, the health impact assessment of kidney diseases caused by air pollution is very limited. Kidney disease is a disease that is likely to have co-existing with cardiovascular disease, and air pollution has a great effect on vascular disease, so it is expected that it will adversely affect kidney disease. In this study, we investigated the relationship between air pollutants and kidney disease exacerbations in Seoul using national sample cohort data from National Health Insurance Service in Korea. The data includes about 1 million subjects and the period is from 2002 to 2013. It includes medical examination details, medical history, prescription history, and personal information for all members of the health insurance scheme and the beneficiaries. The analyzed areas were Seoul, and persons including N17 and N18 of the Korean Standardized Disease Code in the main disease / injuries on the medical service statement were selected as the study subjects. Because of the nature of the illness, we excluded all cases such as reserved medical care. Therefore, this study limited the subjects to emergency hospitalization to confirm the short - term effect of air pollution on kidney disease. Air pollution data are on the following five substances: carbon monoxide (CO), ozone (O<sub>3</sub>), fine dust (PM<sub>10</sub>), nitrogen dioxide (NO<sub>2</sub>), idealized sulfur (SO<sub>2</sub>). We used case-crossover analysis. The control day was selected for the same day of the month (28) as the case day for exposure to air pollution. Acute kidney disease was affected by air pollution but relatively chronic kidney disease was less affected by air pollution. Especially, in case of acute renal disease, the risk of emergency hospitalization increased with increasing SO<sub>2</sub>, and the delayed effect showed that the risk increased with lag.

## **P02.1690. Effect of Traffic-Related Air Pollution on Spontaneous Baroreceptor Sensitivity: A Trial of In-Vehicle Filtration**

Michael Young

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Abstract: Human controlled exposure studies suggest that diesel exhaust causes acute changes in blood pressure that are mediated by sympathetic activation, but it is unknown whether this sympathetic response might also cause imbalance directly affecting cardiac autonomic control. Baroreceptor sensitivity (BRS) measures rapid compensatory regulation of heart rate in response to acute changes in blood pressure. Using a crossover trial of real-world in-vehicle commutes, we tested whether exposure to traffic-related air pollutants (TRAP) affects spontaneous BRS in healthy subjects. Young healthy participants were driven through heavy Seattle, WA traffic for two hours on three different days, each separated by several weeks. On two days, on-road air was entrained into the cabin through the vehicle's factory air vents and sham filters. On another day, the vehicle was equipped with effective filtration. Exposure was double-blinded and participants were randomized to order of exposure. Three minute intervals of continuous blood pressure and pulse intervals were recorded before, during, and up to 24 hours after drive using a Finapres finger pulse waveform device. BRS was calculated as the reduced major axis slope for change in pulse interval per change in blood pressure for rolling 10 second intervals. On filtered days in-vehicle average particle count was reduced by 85%. We used a mixed effects model on the outcome of change from pre-drive BRS measurements, comparing filtered versus unfiltered day at all thirteen time points in nine subjects with measurable BRS, after excluding a single subject with very large changes in BRS. A likelihood ratio test for the effect of filtration on BRS at all time points was not significant ( $p=0.95$ ). At 7 hours after drive start, BRS, relative to pre-drive levels, was on average 1.01 ms/mmHg higher (95% CI:-7.4, 9.4) in unfiltered drives compared to filtered drives. In conclusion, we did not find evidence that TRAP inhalation causes acute change in BRS.

**P02.1700. Consumption of Fruits and Vegetables Might Mitigate the Intermediate-Term Effects of Ambient Particulate Matters on Fasting Blood Glucose, Blood Lipids in Chinese Children**

Suhan Wang

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**Abstract:** Background: Evidences on the effects of ambient particles with diameters  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) and PM<sub>10</sub> on fasting blood glucose, blood lipids are quite limited among children and the effect modifications by dietary fruits and vegetables remain largely unknown. Objectives: The study aimed to assess the associations between intermediate-term exposure of PM<sub>2.5</sub>, PM<sub>10</sub> and fasting blood glucose, blood lipids in Chinese children. Methods: This study enrolled 4234 children in 5 elementary schools (aged 6-12 years) from 5 districts in Guangzhou, during the period from March, 2017 to May, 2017. Individual PM<sub>2.5</sub> and PM<sub>10</sub> exposures during 6 months before each physical examination were retrospectively estimated by inverse distance weighting interpolation and time-weighted approach according to home address, school address and individual activity patterns. Multivariable linear regression models were used to evaluate the relationships between airborne particulate matters and fasting blood glucose (GLU), total cholesterol (CHO), triglyceride (TG), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL) after adjusting for other covariates. Results: We found per 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub> level during the 6-month mean exposure was associated with elevation of 0.26 (95% CI: 0.18, 0.34) mmol/L in GLU. Moreover, with per 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>10</sub> level during the 6-month mean exposure, significant association with decreased HDL was observed, with the estimated coefficient and 95% CI of -0.04 (95% CI: -0.06, -0.02) mmol/L for HDL. Lower effect estimates were observed among subgroups with higher consumption of fruits and vegetables, lower intake of sugar-sweetened beverages (SSBs). Conclusions: Our study revealed that exposure to ambient PM<sub>2.5</sub> and PM<sub>10</sub> could lead to worsening fasting blood glucose level and blood lipids levels in Chinese children, and lower SSBs intake, higher consumption of fruits and vegetables could mitigate these effects.

## **P02.1710. Acute Effects of Ambient Fine Particulate Matter on Blood Pressure: Results from the Airless Study**

Yiqun Han

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**Abstract:** Background Epidemiological studies have confirmed the link between exposure to fine particulate matter (PM<sub>2.5</sub>) and risk of cardiovascular diseases (CVDs), however, the underlying mechanisms remain unclear. PM<sub>2.5</sub> may increase the risk of CVDs through its effects on blood pressure (BP). Methods Using data from the Effects of AIR pollution on cardiopuLmonary disEaSe in urban & rural reSidents in Beijing (AIRLESS) study, we examine the acute effect of ambient PM<sub>2.5</sub> on BP. During the period of Nov-Dec 2016 (winter) and May-Jun 2017 (summer), 250 participants aged 40-70 years living in an urban or a rural site of Beijing were enrolled. Ambient PM<sub>2.5</sub> concentrations were measured hourly at each site during this period with stationary ambient monitors (BAM/TEOM). Twelve seated BP measurements were taken across 4 visits for each participant (2 visits per season). The association between PM<sub>2.5</sub> and BP was examined with a linear mixed-effects model adjusted for demographic, socioeconomic status (SES) and habitual parameters, ambient temperature and relative humidity. Results The daily mean (standard deviation [SD]) ambient PM<sub>2.5</sub> concentrations during winter and summer campaign were 85.5(78.7) and 48.7(19.2) µg/m<sup>3</sup> in the urban site and 134.0(110.9) and 31.4(14.6) µg/m<sup>3</sup> in the rural site, respectively. Preliminary analyses indicates that increased exposure to ambient PM<sub>2.5</sub> (per interquartile range [IQR] increase: 55.9-57.6 µg/m<sup>3</sup>) during the prior 1-3 days is significantly associated with elevated systolic BP ranging from 1.2 (95% Confidence Interval: 0.7-1.7) to 1.8 mmHg (1.3-2.4), after adjusting for covariates (all P<0.001). Similar results were found for diastolic BP. However, the association between PM<sub>2.5</sub> and BP was no longer statistically significant after further adjustment for ambient temperature and relative humidity. Conclusions PM<sub>2.5</sub> may exert adverse effects on BP, but this positive association was largely explained by temperature and relative humidity.

## **P02.1740. Air Pollution Exposure and Pulmonary Vascular Morphology in the Framingham Heart Study**

Mary Rice

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**Abstract:** Background: Controlled exposure of rodents to particle pollution has been found to cause pulmonary arteriolar vasoconstriction and increased right ventricular pressure, but few studies have assessed if outdoor pollution exposure affects the pulmonary vasculature in generally healthy adults. Aims: To evaluate associations of long-term exposure to fine particulate matter (PM<sub>2.5</sub>), elemental carbon (EC, an indicator of combustion-related pollution), and distance to a major road with radiographic measures of pulmonary blood volume and distal vascular pruning among community-dwelling adults. Methods: We determined the total blood volume (TBV) of the pulmonary arterial and venous vasculature, and the percent of pulmonary blood volume in vessels with a cross-sectional area less than 5 mm<sup>2</sup> (BV5%, a measure of distal vascular pruning), using an automated CT algorithm among 2,470 Framingham Heart Study chest CT sub-study participants from 2008-2011. We assigned distance to major roadway, average PM<sub>2.5</sub> from 2004-2008 using a spatio-temporal model based on satellite data, and 2004-2008 average EC using a spatio-temporal prediction model using chemical transport data. Linear regression models of each exposure and TBV and BV5% were adjusted for age, sex, height, weight, cigarette smoking, second-hand tobacco, census tract median housing value, cohort (Offspring or 3rd Generation), and date of CT scan. Results: Mean (standard deviation, SD) TBV was 143.1 (31.0) mL and mean (SD) BV5% was 39.3 (4.1) %. Median (interquartile range, IQR) 5-year average exposure was 9.9 (1.3) µg/m<sup>3</sup> for PM<sub>2.5</sub> and 0.44 (0.14) µg/m<sup>3</sup> for EC. In fully adjusted models, living close to a major road, and the 5-year average of PM<sub>2.5</sub> and EC were not associated with TBV or BV5%. Conclusions: We did not observe any associations between exposure to traffic- and combustion-related pollution during adulthood and pulmonary vascular morphology on CT at contemporary pollution levels in the Northeastern United States.

## **P02.1750. Exposure to Ambient PM2.5 during Pregnancy and Preterm Birth in Metropolitan Areas of the State of Georgia**

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**Abstract:** Background: A number of studies has pointed to air pollution as an additional factor that could be associated with preterm birth. We assessed in this study the association between exposure to PM2.5 in ambient air during pregnancy and preterm birth in metropolitan areas of the State of Georgia where the rate of preterm birth has been among the highest in the nation over the years. Methods: Birth data were obtained from the National Center for Health Statistics natality dataset. The study population consisted of 53,094 single live births between January 1 and December 31, 2004 in nine metropolitan counties of Georgia. Preterm birth was defined as birth, which occurs before 37 weeks of gestation. County-level air quality index (AQI) data obtained from the U.S. Environmental Protection Agency (EPA) was used to estimate individual exposure levels of PM2.5 for each study participant based on the county of residence for the duration of the pregnancy. A multivariate logistic regression analysis was conducted to assess the association, adjusting for potential confounders. Results: Of the infants whose mothers resided in the nine metropolitan counties of Georgia, 4,543 (8.6%) were preterm birth. A higher rate of preterm birth (9.8%) was observed in infants whose mothers were exposed to ambient PM2.5 with AQI values > 50 than the ones with AQI ≤ 50 (EPA standard for good air quality conditions). Infants with exposure to PM2.5 at the average AQI values greater than 50 during the entire pregnancy were at increased risk of preterm birth (odds ratio: 1.17; 95% CI: 1.09, 1.26), after adjusting for sex of infant, mother's age, race/ethnicity, education, marital status, prenatal care, cigarette smoking, and alcohol consumption. Conclusion: The study provides more evidence on the role of PM2.5 in preterm birth. Reducing exposure to ambient particulate matter, especially in urban areas, for pregnant women would be necessary to improve the health of infants.

## **P02.1760. Air Pollution and Gestational Diabetes in New York City**

Seung-Ah Choe

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**Abstract:** Background: Emerging studies suggest a potential association between ambient air pollution and risk of gestational diabetes mellitus (GDM), but results have been heterogeneous. Method: We evaluated the relationship between ambient fine particulate matter (PM<sub>2.5</sub>) and NO<sub>2</sub> and GDM among 256,372 singleton births in New York City in 2008 - 2010. We linked birth certificates to hospital discharge diagnoses and estimated air pollution exposure based on maternal address. The New York City Community Air Survey provided refined estimates of PM<sub>2.5</sub> and NO<sub>2</sub> at the maternal residence. We used logistic regression to estimate the association between exposures to PM<sub>2.5</sub> and NO<sub>2</sub> in the first and second trimester and risk of GDM, adjusting for maternal age, ethnicity, education, Medicaid status, parity, conception year, deprivation index, pre-pregnancy body mass index (BMI) and delivery hospital. Result: GDM was identified in 6.7% of all singleton births. PM<sub>2.5</sub> during the 2nd trimester was positively, but not statistically significantly associated with risk of GDM. Specifically, we found an odds ratio (1.08, 95% CI: 0.99, 1.17) for GDM per 10 ug/m<sup>3</sup> shift in 2nd trimester PM<sub>2.5</sub>. The odds ratio increased to 1.16 (95% CI: 1.05, 1.28) after further adjustment for 2nd trimester NO<sub>2</sub>. PM<sub>2.5</sub> in the first trimester and NO<sub>2</sub> in either trimester were associated with lower risk of GDM, reaching statistical significance in some analyses. Conclusion: There was some suggestion that PM<sub>2.5</sub> exposure during the 2nd trimester is associated with a higher risk of GDM. However, we also found some evidence of negative associations with 1st trimester PM<sub>2.5</sub>, and NO<sub>2</sub> in both trimesters, complicating interpretation.

## **P02.1770. Studying Symptoms and Risk Perception in a Contaminated Site: A Valuable Connection**

Fabrizio Minichilli

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**Abstract:** Long-term exposures to air pollution have shown increased risks of developing chronic respiratory diseases, and short-term exposures have been associated with excesses of bronchitis, asthma and respiratory symptoms. A Health Impact Assessment process carried out in the Valley of Agri River (Basilicata, Italy) where is located a crude oil treatment plant, included a population cohort study, a sample study to assess respiratory function and symptoms and risk perception. The main pollutants emitted are NO<sub>x</sub>, H<sub>2</sub>S and VOCs, particularly non-methane hydrocarbons. On 6,795 residents, a sample of 200 healthy subjects, aged 18-74 years, was randomly selected, stratifying by gender, age group and home address in two areas: proximal or distal. For each subject, a spirometry test was performed and a questionnaire administered for characterizing anamnestic history, respiratory symptoms, socio-economic data and risk perception. Measured functional parameters and declared respiratory symptoms were compared between the two areas by using a multivariate logistic regression, adjusted for BMI, smoking, occupational exposure, cardio-vascular comorbidity. Nine subjects showed a bronchial obstruction after bronco-dilator testing. For most of the symptoms a higher risk in the proximal aerea emerged: for cough outside the common colds for some periods of the year and respiratory allergic symptoms associated with eye symptoms, it was statistically significant (OR 2.46 IC95 % 1.02-6.11; OR 2.53 CI95% 1.29-4.94). Risk perception was the same among the subjects residing in the two areas: high perception of exposure to air pollution or to develop asthma was declared in 38% and 67% respectively. Although the small sample size, the excesses of risk emerged for some respiratory symptoms, for which a bias due to risk perception can be ruled out, represent an important result to be used to improve the environment and health sustainability through the implementation of an ad hoc surveillance system.

**P02.1780. Ambient Air Pollution and Emergency Department Respiratory Disease among Adults in Jefferson County, Alabama, U.S.A.**

Meghan Tipre

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**Abstract: Background/Aim.** Most air pollution studies model exposure using large geographical units (city/county), resulting in exposure misclassification. In this study we evaluated the relationship between zip-code specific ambient air pollutants and emergency department visits (EDV) for respiratory diseases (RDs) in Jefferson County (JC), Alabama. **Methods.** EDV records for adult patients ( $\geq 18$  years) for RDs were obtained from eight of 11 hospitals in JC from 1999-2009. Data on PM<sub>2.5</sub>  $\mu\text{g}/\text{m}^3$ , PM<sub>10</sub>  $\mu\text{g}/\text{m}^3$ , ozone and speciated compounds from JC monitors were used to model daily exposures for the 67 residential zip codes. Using GAM with Poisson log-link function and splines, risk ratios were computed, adjusting for covariates. Expanded analysis included single-day and moving-average lagged exposure, alternately adjusting for average or range temperature and stratification by seasons. **Results.** A positive association between PM<sub>2.5</sub> (RR, 1.002, 95%CI, 1.002-1.003) and PM<sub>10</sub> (RR, 1.003; 95%CI, 1.003-1.004) and all RD was noted; results were similar for upper respiratory infection (URI) and asthma. Ozone was negatively associated with all RDs (RR, 0.999; 95%CI, 0.998 - 0.999), asthma and URI, limited to winter months (RR, 0.996; 95%CI, 0.995 - 0.997); summer months, (RR, 1.00; 95%CI, 0.999-1.0004). Speciated pollutants including CO, EC, MMO, NH<sub>4</sub>, NO<sub>3</sub>, OC, SO<sub>2</sub>, SO<sub>4</sub>, and TC were positively associated with all RDs, URI and asthma. Strongest associations were noted for 0-8 days moving-average lagged PM and speciated pollutants, particularly NH<sub>4</sub> (RR, 1.022; 95%CI, 1.011-1.033); NO<sub>3</sub> (RR, 1.914; 95%CI, 1.812-2.02), OC (RR, 1.03; 95%CI, 1.023-1.037); and TC (RR, 1.018; 95%CI, 1.012-1.025) and asthma; similar patterns were observed for all RDs and URI. **Conclusions.** PM<sub>10</sub>, PM<sub>2.5</sub> and speciated pollutants increase risk of ED visits for RDs in adults with stronger effects observed with lagged exposures. Possible effect modification by seasons for ozone exposure and RDs were observed.

**P02.1790. Assessment of Hypothetical Nitrogen Dioxide and Particulate Matter Concentration Interventions on Asthma Incidence in Southern Californian Children: A Causal Inference Approach**

Erika Garcia

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Abstract: Numerous observational studies have linked air pollution with incident childhood asthma. We implemented g-computation, a method based in the counterfactual framework, to estimate the effect on asthma of hypothetical air pollution interventions in a population of Southern California children. We used data from the three cohorts in the Southern California Children's Health Study (recruited in 1993, 1996, and 2002) with prospectively identified incident asthma cases and continuously monitored nitrogen dioxide (NO<sub>2</sub>) and particulate matter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>). Multilevel Poisson regression models were developed to estimate the relation between asthma incidence and baseline year annual average pollution concentration, adjusted for potential confounders. For both NO<sub>2</sub> and PM<sub>2.5</sub> we estimated the effect on asthma of 1) remaining at 1993 concentrations-the highest of all three time points-and 2) several hypothetical air quality standards-dynamic interventions where air pollution were reduced to a standard only in communities exceeding the hypothetical standard. All comparisons are to the natural course. The three cohorts included 4,140 children with no history of asthma at baseline and an average of 5.9 years of follow-up (mean baseline age: 9.5 years; 53% female; 55% White; 41% Hispanic). Remaining at 1993 NO<sub>2</sub> levels was estimated to increase asthma incidence by 19.4% (95% CI: 9-32%), whereas implementing hypothetical standards of 30, 20, and 10 ppb were estimated to reduce asthma incidence by 7.2%, 19.5%, and 39.0% respectively. For PM<sub>2.5</sub>, there was an increase of 9.7% (0.8-20%) estimated for remaining at 1993 levels and reductions of 10.8%, 14.7%, and 17.5% for implementing hypothetical standards of 15, 12, and 10  $\mu\text{g}/\text{m}^3$ , respectively. Had NO<sub>2</sub> and PM<sub>2.5</sub> not improved over the study period we expect there would have been more childhood asthma cases; however, had air pollution levels been lower than observed there would have been even lower asthma incidence.

## **P02.1800. Exposure to Smoke from a Coal Mine Fire during Infancy and Lung Function Three Years after the Event**

Fay Johnston

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**Abstract:** **BACKGROUND:** In 2014, emissions from a fire in an open cut coal mine caused markedly increased concentrations of fine particulate matter (PM<sub>2.5</sub>) in the Latrobe Valley of Victoria, Australia, for approximately six weeks. We aimed to evaluate the lung function of infants who were less than two years of age when exposed to the air pollution from the fire. **METHODS:** Daily average and maximum PM<sub>2.5</sub> exposures were calculated for each participant according to their daily location throughout the fire period. Lung function was measured three years after the fire using the forced oscillation technique. The primary outcomes were z scores for resistance at 5Hz (Rrs5), a measure of airways obstruction, and two indicators of lung stiffness, reactance at 5Hz (Xrs5) and the area under the reactance curve (AX). We used generalised linear models, adjusted for maternal smoking in pregnancy, maternal stress during the fire and maternal education to assess associations between PM<sub>2.5</sub> and lung function. **RESULTS:** We tested 83 children, who had a mean age(SD) of 4.3(0.5) years at the time of follow up. Median [IQR] average PM<sub>2.5</sub> exposure was 8.9 [7.2-19.3] µg/m<sup>3</sup> and maximum PM<sub>2.5</sub> was 29.0 [16.1-49.9] µg/m<sup>3</sup>. The mean(SD) z scores of participants were Rrs 0.6 (0.8), Xrs -0.8(0.9) and AX 0.7(0.9). A 10µg/m<sup>3</sup> increase in average PM<sub>2.5</sub> exposure during the fire period was independently associated with z scores for Rrs 0.18 (95%CI 0.01,0.34, p=0.038), Xrs -0.20 (-0.36, -0.04, p=0.015), and AX, 0.25 (0.07 to 0.42, p=0.006). In addition, maternal smoking in pregnancy was strongly associated with measures of reactance Xrs5: -1.25 (-1.75, -0.76, p=0.000) and AX: 0.97 (0.42, 1.51, p=0.001). **CONCLUSION:** Exposure to a period of reduced air quality during infancy was associated with reductions in lung function measured three years after the event. The possible long term clinical implications or reversibility of these changes is not known. Further research is required to validate these findings.

**P02.1810. Interaction Effects of Air Pollution and Influenza Vaccination on Allergic Respiratory Diseases and Symptoms in Chinese Children: The Seven Northeast Cities Study**

Kangkang Liu

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**Abstract:** Background Few studies explore the effectiveness of influenza vaccination in children who expose the long-term high-intensity air pollution. Therefore, the aim of this study is to evaluate the potential roles of interaction effects between air pollutions and influenza vaccination on children's allergic respiratory diseases and related symptoms. Methods A cross-sectional survey was conducted on 56,137 school-aged children from 27 administrative districts in seven cities in north China. Parents of the children helped to complete questionnaires which contain the social demography characters, histories for respiratory symptoms and illness of children, the environment for dwelling, school, or other activities areas, the situation of influenza vaccination and other risk factors. A multi-level logistic regression model was used to analyze the roles of interaction effects between influenza vaccine and air pollution on children's respiratory health. Results Among the vaccine groups compared with the unvaccinated group, the lower incidence rates were appeared in the symptoms of asthma, current diagnosis of asthma, wheezing, cough, phlegm and rhinitis. The significant effects of interactions between particulate matters (PM) and influenza vaccine inoculation for PM1.0 and PM2.5 on children's symptoms of asthma were found ( $P < 0.01$ ). The associations between PM2.5 exposure and asthma were weaker in the children with influenza vaccination (OR: 1.213, 95%CI: 1.159, 1.269) than the children without influenza vaccination (OR: 1.332, 95%CI: 1.280, 1.387). The interaction effects between PM2.5 and influenza vaccine among boys with current asthma were significant ( $P = 0.023$ ). Conclusions The potential effects of interactions between air pollutions and influenza vaccine inoculation on children's respiratory health were found in this study. The differences of the susceptibility of asthma between boys and girls were found when the children exposed air pollutions and influenza vaccination.

## **P02.1820. Association of PM2.5 Exposure and Health Outcomes in a Representative Population Sample of the Mexico City Metropolitan Area Using Satellite and Monitor-Based Exposure Estimations**

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**Abstract:** **BACKGROUND:** Air pollution is a key global public health challenge. The Mexico City Metropolitan Area (MCMA), a megalopolis of 23 million people, exceeds the WHO's recommendation for the annual average of PM2.5 level. **AIM:** To estimate the association of PM2.5 exposure and acute respiratory tract symptoms (ARTS) in children, and with ischemic heart disease (IHD) and hypertension (HT) in adults, in a representative sample of the MCMA population. **METHODS:** Participant health information was obtained from the National Survey of Health and Nutrition 2006 and 2012. Exposure to PM2.5 was estimated using 1, 3, 7, 14, 30 and 365-day averages before day-of-interview from the city monitoring network (MNW) and a satellite-based model (SM). We used logistic regression models, adjusted for age, sex and socio-economic status considering the sampling design **RESULTS:** The sample represented 3.1 and 3.6 million children and 12.7 and 13.8 million adults in 2006 and 2012, respectively. Annual PM2.5 estimation was higher using MNW vs SM (SM: 2006: 25.9; 2012: 24.8  $\mu\text{g}/\text{m}^3$  vs MNW 2006: 29.0; 2012: 26.7  $\mu\text{g}/\text{m}^3$ ). We saw decreased annual averages with both estimation methods, but they both double the Mexican standards. We found a positive association between 2-week PM2.5 exposure and ARTS, with both exposure methods, statistically significant in 2006 using the MNW (OR: 1.46, 95%CI: 1.00-2.15. Positive associations with IHD and previous year exposure were estimated using MNW, however they were non-significant for both surveys. The results using SM were inconclusive. For HT and previous year exposure, we observed a positive association using SM in both surveys, significant for 2012 (OR: 2.54; 95%CI: 1.12-5.77). The estimates using MNW were inconclusive. **CONCLUSIONS:** There were positive associations between PM2.5 exposure and acute and chronic diseases. For acute outcomes, MNW estimations seems to better capture the daily variability in PM2.5, whereas for chronic diseases both methods can be useful.

## **P02.1830. PM10 Exposure and Bronchiolitis from Respiratory Syncytial Virus among Infants**

Dario Consonni

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**Abstract:** Background: Respiratory syncytial virus (RSV) ranks first among the causes of acute lower respiratory infections in children. The most common clinical syndrome associated with RSV infection is bronchiolitis (RSV-B). Air pollution might influence the inflammatory cascade that brings to RSV-B. Aims: To investigate the association between PM10 exposure and the risk of hospitalization for RSV-B. Methods: We selected hospital discharge records (HRD) with ICD-9-CM code 466.11, referring to infants <1 year of age, and occurring in the epidemic seasons of 2012-2013 in Lombardy, Italy. Each case was assigned daily PM10 and apparent temperature (AT) levels of the provincial capital city of residence. Different time windows were considered: single days preceding hospitalization (lag 0 to 30), their average estimates (lag 0-1 to 0-30), the weeks preceding hospitalization (week 1 to 4). We applied negative binomial regression models adjusted for AT and season to the daily counts of hospital admissions in each province. Random effects meta-analyses of province-specific estimates were performed to obtain regional values. Results were expressed as incidence rate ratios (IRR) and 95% confidence intervals (95%CI) per 10µg/m<sup>3</sup> increase in PM10 concentration. Results: 2,814 HRD were included (males = 55%). We observed an increased hospitalization risk of 6% at lag 0 and of 7% at lag 1 (95%CI: 1.03-1.10 for both). IRR ranged from 1.03 to 1.05 between lags 2 and 11, and no risk increase was observed from lag 12. Analyses on averaged daily lags showed increased risks in the two weeks preceding hospitalization, with IRR from 1.08 (1.04-1.12) at lag 0-1 to 1.15 (1.08-1.23) at lag 0-13. When considering weekly lags, a 6% (1.01-1.12) and a 7% (1.02-1.13) increased risks were observed during weeks 1 and 2, respectively. Conclusions: Our study improved the body of evidence on the association between short- and medium-term PM10 exposures and the risk of hospitalization for RSV-B among infants.

## **P02.1840. Estimating Asthma, Myocardial Infarction, and Heart Failure Hospitalizations and Emergency Room Visits in New York City from PM2.5 Exposure Using a Bayesian Modeling Approach**

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Abstract: Fine particulate matter has been shown to influence the frequency and severity of respiratory and cardiovascular diseases, and also increases inflammatory proteins and heart rate variability (HRV). The typical air pollution-focused health study uses concentration data from the nearest ground-based air quality monitor(s), which have missing data on the temporal scale due to filter collection schedules (once every 3 days or once every 6 days), and on the spatial scale due to monitor placement. To overcome these data gaps, this project used a Bayesian model to generate estimates of PM2.5 in areas with and without air quality monitors. This was achieved by combining PM2.5 concentrations measured by monitors, PM2.5 concentration estimates derived from satellite aerosol optical depth (AOD) data, and Air Quality model predictions of PM2.5 concentrations, into ambient concentration surfaces covering selected geographic areas. The objectives of this study were to: 1) demonstrate that the inputs to the model could include AOD data in addition to measurement data from monitors and modeling estimates from air quality models, and; 2) determine if inclusion of AOD surfaces in Bayesian model algorithms resulted in air pollutant concentration surfaces which accurately predicted hospital admittance and emergency room visits for MI, asthma, and HF. The focus was the New York City, NY metropolitan and surrounding areas from 2004-2006. The results showed PM2.5 exposures above the National Ambient Air Quality Standard (NAAQS) value (12 mg/m<sup>3</sup>) were associated with increased risk of asthma, MI and HF. Estimates derived from concentration surfaces incorporating AOD had a similar estimate of risk as compared to those derived from combining monitor and CMAQ data alone. This study demonstrated that PM2.5 concentrations from satellite data can be used to supplement PM2.5 monitor data and air quality model estimates of PM2.5 in assessing risk associated with three common health outcomes.

## **P02.1850. Persistence of Wildfire-Derived Pollutants in Indoor Environments after 2016 Fort McMurray Wildfires**

Arthur Chan

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Abstract: The 2016 wildfire in Fort McMurray forced the evacuation of all 88 000 residents, and destroyed 15 % of the town's built structures. Re-entry was delayed after initial tests revealed elevated concentrations of the toxic elements Cr, As, and Sb and polycyclic aromatic hydrocarbons (PAHs) in fire ashes. No studies exist so far that investigate if and how long wild-fire derived pollutants are retained in indoor environments and pose a long-term health risk to residents. We report initial results from a house dust sampling campaign carried out 14 months after the fire. We compare dust samples from 62 houses to urban and forest-floor ash collected during the Fort McMurray wildfire, background studies, and regulatory guidelines (Alberta Tier 1 guideline for residential soils). Concentrations of Cr, As, and Sb in Fort McMurray (geom. mean 45, 4.2, and 6.5 ppm) were comparable to those in background studies (geom. mean 101, 7.7, and 5.5 ppm). Our dataset, however, showed a higher variability of Sb concentrations, such that the most polluted houses of our study (95%-percentile: 46 ppm) exhibited significantly higher concentrations than in the background study (15 ppm). Pollutant concentrations in ash samples differed between urban and rural areas. Urban areas exhibited high concentrations (200-3000, 100-1300, and 20-300 ppm; n=3) that exceeded regulatory guidelines (64, 17, and 20 ppm), while concentrations in forest-floor ash samples were typically below those found in house dust samples (7-300, 1-12, and 0.1-3 ppm; n=5). We also report high levels of volatile PAHs (naphthalenes) in both fire ash and dust in homes heavily damaged by the wildfires 14 months after the event. Overall, our results indicate that very high concentrations of pollutants can be found in ashes from urban, but not rural, areas; however, our data do not provide evidence that all pollutants persist in house dust over extended periods of time.

**P02.1860. Evaluation of LPG Use as a Clean Cooking Fuel in South West Cameroon: Findings from Community Surveys from the LPG Adoption in Cameroon Evaluation (Lace) Studies**

Daniel Pope

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**Abstract:** Background: Most households in Cameroon rely on solid fuel for cooking. The government has launched a Master Plan to increase LPG use from <20% to 58% by 2035 to address deforestation and energy security issues. To understand how to support communities transition from solid fuel to LPG, LACE surveys assessed household characteristics and perceptions of LPG in different fuel using groups. Methods: After rapid census, 320 households from rural and peri-urban communities in SW Cameroon were randomly selected into 4 fuel-use groups: exclusive LPG (n=51), primary LPG (n=52), mixed LPG and biomass (n=113) and exclusive wood (n=104). Surveys collected information on (i) household characteristics and fuel use practices, (iii) perceptions of LPG and (iv) experience of health issues and burns. Results: Amongst LPG users, distance from retailer (refills) impacted on more exclusive use (travel > 5km: 15% of LPG exclusive/ primary users vs 24% of LPG mixed). Greater income, education and a younger age were associated with increasing LPG use (p<0.05). Perceptions of LPG as a cooking fuel differed by amount of LPG use. 85% of LPG exclusive users reported LPG could be used for most foods compared to 40% of wood exclusive users (p<0.05). Increasing LPG use was associated with increased reporting of LPG as a clean and fast fuel and cost was less of an issue. In all groups, LPG was perceived as potentially dangerous (>75% reporting). The occurrence of cough and phlegm was low in all groups, whilst a higher proportion of exclusive wood users reported sore eyes (60% vs 29% (LPG exclusive) p<0.005) and burns (23% vs 10% p=0.007) . Conclusion: Potential barriers to adoption and more exclusive use of LPG include its perceived ability to cook most foods, perceptions over its safety and distance from retail outlets. Household income is a strong indicator of usage. Education strategies (health and safety) and financial support mechanisms (e.g. microfinance) could help scaling LPG adoption

## **P02.1870. Estimating Fine-Scale Temporal and Spatial Characteristics of SO<sub>2</sub> Exposures Using U.S. EPA's Air Pollutants Exposure (APEX) Model**

Graham Glen

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**Abstract:** The U.S. EPA Air Pollutants Exposure Model (APEX) is a stochastic model simulating inhalation exposure using fine-scale population demographics, human activity and physiology, time series of ambient chemical concentrations, and parameterizations of chemical infiltration into microenvironments. For a recent high-resolution population-based exposure assessment of three U.S. urban areas (Tulsa, OK; Indianapolis, IN; Fall River, MA), we used APEX to estimate the percent of the study population experiencing 5-minute SO<sub>2</sub> exposures at or above selected benchmark levels (100-400 ppb, 100-ppb increments) and the resultant lung-function decrements. We generated complete time series of 5-minute ambient SO<sub>2</sub> concentrations at thousands of receptors in each study area, combining modeled hourly concentrations with continuous 5-minute ambient measurements for 2011-2013, then adjusted to just meet the current national ambient air quality standard. We developed new model input data and algorithms as a function of sex and age to support the high resolution of this assessment, including data on demographics, commuting patterns, and asthma prevalence at the level of U.S. Census blocks, and algorithms to estimate short-term breathing rates and energy expenditure. Results showed notable differences in SO<sub>2</sub> exposure by location, with fewer elevated exposures and health risks estimated in Tulsa, OK relative to the other study areas. An important factor in these results is the lower numbers of people estimated to live or work in areas of higher SO<sub>2</sub> concentrations in the Tulsa scenario relative to the other scenarios. These results indicate the importance of the accuracy and spatiotemporal resolution of the air concentration and population data in estimating population exposures and health risks to inform policy decisions.

## **P02.1880. Infant Exposures to PM-Bound Metals Associated with Household Air Pollution and Cooking**

Ryan Chartier

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**Abstract:** Background Around 3 billion people globally rely on solid fuels for their household energy needs. Exposure to high levels of the resultant household air pollution (HAP) has been linked to a plethora of adverse health outcomes. Until the recent development of the MicroPEM and Enhanced Children's MicroPEM, it was not possible to accurately quantify the levels, patterns, and composition, of personal HAP exposures of small children. Methods The study was carried out at the Karonga Prevention Study, Malawi, where children born in homes with improved (Philips HD4012) and 3-stone stoves were followed at 6 weeks and 6 months. Nasopharyngeal swabs were collected and 48-hour real-time and integrated PM<sub>2.5</sub> exposures were measured using the RTI MicroPEM. Following gravimetric analysis of PM<sub>2.5</sub> mass, the filters were analyzed for 33 metals with x-ray fluorescence spectroscopy. Results Valid personal exposure measurements are available on 694 children. Overall, we did not observe a difference in geometric mean PM<sub>2.5</sub> exposure levels between children in homes with a traditional stove compared to those in intervention homes ( $p=0.153$ ,  $53.4$   $95\%CI[49.9,57.1]\mu\text{g}/\text{m}^3$ ,  $48.0$   $[42.1, 54.6]\mu\text{g}/\text{m}^3$ ; respectively) ( $p=0.153$ ), except when cooking occurred indoors ( $p=0.002$ ,  $91.8$   $[75.1, 112.4]\mu\text{g}/\text{m}^3$ ;  $54.7$   $[42.4, 70.4]\mu\text{g}/\text{m}^3$ ; respectively). Preliminary data show that children in homes using the Philips stove were exposed to higher levels of Aluminium (170%), copper (185%), chromium (240%), and iron (187%), than children living in homes using a traditional 3-stone stove. Conclusions Exposure to PM-bound metals have been shown to have immunotoxic effects in animal models and exposures to high levels of PM-bound metals such as iron have correlated with increased rates of severe pneumonia in some populations. To our knowledge, this is the first study to report direct infant personal exposures of PM-bound metals associated with household air pollution; the first step towards quantifying potential health impacts.

## **P02.1900. Symptoms and Behaviors Related to Wildland Fire Smoke Exposure: Data from the EPA Smoke Sense Citizen Science Smartphone Application**

Steven Prince

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**Abstract:** Exposure to smoke from wildland fires is associated with an increased incidence of health burdens and thus warrants further study to understand behavioral patterns related to exposure reduction efforts. We examine the feasibility of using EPA's Smoke Sense smartphone application (iOS and Android) to engage users during smoke events and investigate the range of actions taken in relation to smoke exposure and symptoms experienced. Users of the application reported on the presence or absence of a smoke event in their area, symptoms they experienced and number of days, averting actions (protective measures such as avoiding outdoor recreational activity, staying indoors, using a respirator mask, using an air cleaner, etc.), and mitigating actions (taking medication or seeking medical care) they may have taken. Users reported symptoms (across four categories: eyes and ears, respiratory, cardiovascular, other) and their severity (e.g. did they need to take mitigating action). The majority reported previous health conditions relevant to the effects of air pollution. Among those who experienced smoke events, the average number of symptom days was 2.5 compared to 0.8 during non-smoke periods, and the odds of reporting symptoms were 4.1 to 11.8 times greater than during non-smoke periods. Averting and mitigating actions have varying "costs," including financial, time, effort, social etc. For example, users could report no averting actions (no costs), staying indoors (some cost), avoiding daily activities such as work (high cost) or seeking medical care (high cost). We examine the extent to which averting and mitigating actions impact symptom severity and the extent to which cost impacts the likelihood of adopting these actions. Using regression models and mediation analyses, we describe relationships between smoke exposure, averting and mitigating actions, and symptoms experienced. Disclaimer: The views expressed do not necessarily reflect the views or policies of the U.S. EPA.

## **P02.1910. Volatile Organic Compounds in Homes in Shanghai, China: Identification of Pollutant Sources and Impact of Air Purifier Use on Pollutant Levels**

Christina Norris

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**Abstract:** Although Chinese residents spend the majority of their time indoors, pollutants in the indoor environment have not been studied as extensively as their outdoor counterparts. This is especially true of volatile organic compounds (VOCs), many of which are associated with adverse health outcomes and have indoor sources. For this study, 20 homes with asthmatic children were recruited from the suburbs of Shanghai, China. This study explored pollutants and the impacts of air filtration on pollutant levels. Air purifiers were installed twice, for two-week periods, in the child's bedroom - once with all levels of filtration (pre-filter, HEPA filter, carbon filter) and again with only a coarse pre-filter. During both periods, indoor and outdoor samples were collected simultaneously on Tenax and DNPH tubes in the early morning using pump packages developed at Duke University. Of the 900+ compounds detected, 117 were detected in 10 or more samples. Total VOCs were higher indoors than outdoors in most homes under both conditions (median values [in mg m<sup>-3</sup>] - sham, in/out: 235/59; true, in/out: 119 /77). There was a significant reduction in indoor-outdoor ratios during true compared to sham filtration indicating a potential benefit of filtration (median reduction: 36%, range: -224%, 96%). Non-negative matrix factorization was used to identify groupings of compounds (features) illustrative of sources. Of the features identified, two indicate outdoor sources with certain compounds detected in most outdoor samples but seldom detected indoors. The other three features point to indoor sources. Preliminary analyses indicate compounds detected predominantly indoors may relate to cleaning or personal care products, although analysis is ongoing. This work provides new insight to potentially harmful compounds in Chinese homes, as most previous studies have focused on assessment of total VOCs or select, well-characterized VOCs including BTEX and formaldehyde.

## **P02.1920. Ultrafine and Fine Particulate Matter Levels over Resurfacing Operations at Skating Arenas**

Sunil Varughese

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**Abstract:** Background: Ice arenas are a unique public indoor space where there is extensive use of combustion engines combined with an exercising population. This pilot study seeks to identify ultrafine particle (UFP) levels and fine particulate matter (PM<sub>2.5</sub>) in indoor ice arenas across resurfacing operations. Ice making is a time-consuming and expensive process. In order to preserve the ice and ensure a smooth surface, arena operators resurface ice based on usage. Ice resurfacing involves driving a resurfacing machine over the surface of the ice as it simultaneously scrapes off a thin layer of ice and fills scratches with water, resulting in a smooth and even ice surface. Pollutants can be trapped near the ice from stagnant air flow due to a combination of boards and glass surrounding the ice and a thermal inversion which keeps colder air near the ice surface.

**Methods:** UFP and PM<sub>2.5</sub> measurements were continually collected using a TSI P-Trak and a TSI Dusttrak DRX. Samples were run indoors before, during and for approximately 20 minutes after one resurfacing event to capture changes in particle levels throughout the event and outdoor background measurements were taken. Sampling was conducted on two separate days in 12 arenas, once in the morning and once in the afternoon. Arenas were selected that differed in their ventilation characteristics and resurfacing equipment (7-propane, 3-natural gas, 1-gasoline, 1 electric).

**Results:** Mean resurfacing time was 9.1 minutes (range 6-16) and was performed hourly during high arena usage. Peaks in UFP were typically observed 10 minutes post resurfacing with a mean increase in peak UFP from pre- to post- resurfacing across arenas of 65% (range 13-400%). However, PM<sub>2.5</sub> levels were not elevated following resurfacing operations. **Conclusion:** The poster will provide results on changes in UFP levels by fuel type of resurfacer.

## **P02.1930. A New Method, $\eta$ -Indoor Particle Age Method, of Estimating Indoor Airborne SVOC Concentrations**

Yinping Zhang

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**Abstract:** To appropriately assess exposure to indoor semi-volatile organic compounds (SVOCs), a convenient but relatively accurate method considering the non-equilibrium sorption behavior between their gas-phase concentration ( $C_g$ ) and particle-phase concentration ( $C_{sp}$ ) is needed. There are two reasons: (1) the equilibrium model frequently used in previous studies may result in significant errors because the time that particles stay in the indoor air is often much shorter than the critical time for  $C_g$ - $C_{sp}$  equilibrium; (2) several dynamic models in the literature took the mean residence time of indoor airborne particles as the time duration of the mass transfer between SVOCs and particles in the indoor environments, which may obviously reduce their accuracy because residence time varies among individual particles, and the  $C_g$ - $C_{sp}$  relationship and residence time are not linearly correlated. Therefore, we put forward a new concept, indoor particle age (the time that airborne particles have spent since entering the room), and develop a method, named as " $\eta$ -indoor particle age method" to address the aforementioned problems. The  $C_{sp}/C_g$  value can be obtained by multiplying the equilibrium result by a modification factor,  $\eta$  (which is a function of indoor particle age, particle size distribution and the critical time for  $C_g$ - $C_{sp}$  equilibrium). The  $\eta$ -indoor particle age method can reduce the relative errors of the equilibrium model by over 1000% for many scenarios, and the existing dynamic models by over 30%, which are preliminarily supported by the experimental results in the literature. In addition, the method is useful in determination of the partition coefficients between indoor particles with different sizes and various gas phase SVOCs.

**P02.1950. Change in Indoor Formaldehyde Concentration and Prevalence of Subjective Symptoms in Medical Students Exposed to Formaldehyde during Gross Anatomy Dissection Classes, and Effectiveness of Exposure Prevention by Wearing Personal Protective Equipment**

Mihoko Mori

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Abstract: In Japan, medical students are exposed to formaldehyde (FA) during gross anatomy dissection classes. Students complain various subjective symptoms such as mucous membrane irritation symptoms and unidentified complaints. We have taken ongoing measures to decrease FA exposure at our university. Wearing personal protective equipment (PPE) such as gas masks and safety glasses is effective in reducing exposure to FA, as shown by previous studies. This study evaluated correlation with FA concentration in an anatomy practical room and prevalence of 14 symptoms where students experienced during the anatomy practice. Furthermore, we evaluated the effectiveness of prevention by wearing PPE. We conducted brief questionnaire surveys after every practice with second-year students participating in an anatomy class in 2016, concerning 14 subjective symptoms, including eye, nose, and throat complaints, as well as unidentified complaints, and whether or not to wear PPE, their sleep duration of the previous night, the number of cigarettes smoked, and their physical condition during the day in question. And, we measured indoor levels of FA during every practice. Subjective symptoms were classified into four categories. Those answering "very severe" or "severe" were classified as having subjective symptoms. There were significant correlations between FA concentration in an anatomy practical room and prevalence of some symptoms where students experienced during anatomy practice. And we found a certain level of effectiveness of prevention by wearing PPE during the practice. We need to recommend to wearing PPE during the practice, especially at high level of indoor FA concentration.

## **P02.1960. Evaluation of Monitoring Data of Persistent Organic Pollutants for Identification of Sources, Pathways and Trends of Environmental and Human Exposure**

Gerlinde Knetsch

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Abstract: Monitoring data is essential for investigate sources, pathways and the exposition of environment and human beings. The paper concerns with persistent organic pollutants (POPs) and the impact to human health via the food chain. In recent years food monitoring of dioxin-like Polychlorinated Biphenyls (dl PCBs) and non-dioxin-like Polychlorinated Biphenyls (ndl PCBs) has been intensified in Germany. Reasons for this, it has been increasingly found that particularly farm animals from extensive farming (cattle, sheep, laying hens) or the food they produce, partially exceed the EU maximum levels for the sum of dioxins and dl-PCBs (WHO-PCDD/F-PCB-TEQ). The impact is originated come largely from the environment. Humans essentially ingest PCDD/F and PCBs from fatty animal-derived foods such as meat, dairy and eggs and fishery products. Through historic uses PCBs predominantly were released to the environment compartments as well as to feeding stuff for animals. The properties of bioaccumulation and persistence of dl-PCB results in an enrichment in the food chain. The behaviour of other substitute substances namely short-chain chlorinated parafins (SCCP), polybrominated diphenyl ethers (PBDE) and hexabromocyclododecane (HBCD) were investigated in this context, in order to comprehend their ubiquitous appearance well as the mechanisms and pathways of dispersal. Are there analogies to the issues of PCBs? The presentation will give a survey about the congener profile data collected to identify possible causes for contamination of environmental samples, technical products but also for food. The benefit of the data collection in the POP-Dioxin-Database of Germany consists in the harmonisation of the data, an abundance of supporting of metadata and generation of profiles. The presentation will conclude with an outlook on future activities of the German Environment Agency, e. g. concerning data sharing in context of Information Platform for Chemical Monitoring (IPChem).

## **P02.1970. Short-Term PM2.5 Exposure and Cause-Specific Mortality in China: A Multicounty Time-Series Analysis**

Chen Chen

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Abstract: Efforts to understand the acute effects of PM2.5 concentration at low levels on health have a great deal of multiple centers epidemiologic research in developed countries. In order to identify how short-term exposed to PM2.5 can harm human health, it is crucial to estimate the exposure-response relationships at higher exposure. People in China have been exposed to particularly higher levels and few studies conducted in China showed different magnitudes of PM2.5 acute effect. Considering the severe pollution situation and the inconsistent effects, it is worth initiating more in-depth studies to understand of the acute effects of PM2.5 in China. Applying a county-specific quasi-Poisson regression in 59 counties over China Mainland, we estimated PM2.5 effects on death of all nature cause and 11 specific causes during 2013 to 2015. Then we pooled the county-specific results across China using a random effects meta-analysis. We found a 10 µg/m<sup>3</sup> increment in PM2.5 at lag 0-1 day was significantly associated with a 0.14% (95% CI, 0.03-0.25) increase in the risk of all nature cause, a 0.30% (0.01-0.58) increase in stroke, a 0.28% increase (0.07-0.50) in respiratory disease, a 0.29% (0.03-0.55) increase in chronic lower respiratory disease, and a 0.30% (0.03-0.56) increase in COPD. Associations for respiratory causes of death were larger than for cardiovascular causes, while the magnitudes were less than that reported in developed counties. These findings complemented evidence related to exposure-mortality relationships at the higher end of PM2.5 exposure as well as benefited to arrange strategies of health protection targeted to sensitive disease.

## **P02.1980. Effect of Reducing Fine Particle Concentration after Use of Air Purifiers in Hospital: Preliminary Results**

Jongmin Oh

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Abstract: Most hospitals have air-conditioning facilities, but many people are moving, and there are many indoor air pollutants such as fine particle. In this study, air purifier is installed in hospital ward to investigate the improvement of indoor air pollution. We installed 25 air purifiers in 4th floor ward of a university hospital in Seoul, Republic of Korea. The air purifier filter is turned on and off at intervals of 4 weeks, and the indoor fine particle concentration is continuously measured through the dust sensors of the air purifiers. We obtained the outdoor fine particle data from the nearest Air Korea measuring station. We compared indoor fine particle concentrations before and after using the air purifier and compared those after stratification of the types of place (single rooms, rooms with five or six beds, nurse stations, and patient rest room). We also analyzed the average difference and correlation between indoor and outdoor fine particle concentrations. After the use of air purifiers, the difference of indoor and outdoor fine particles concentrations are larger and the correlation between outdoor and indoor fine particle was also lower than that before the use of air purifiers. The average difference of indoor fine particle before and after use of air purifier was about 3.46-5.68  $\mu\text{g}/\text{m}^3$ . Among the four types of places, the nurse stations had the highest concentration of fine particles, the lowest patient rest room, and there was a difference between the groups. Despite having air conditioning facilities in the hospital, indoor fine particle concentration was lower when air purifiers was used than before use of air purifiers. Particularly in places where people are moving a lot in the ward, fine dust is high. Therefore, additional efforts are needed to lower the concentration of fine particle in hospitals such as use of air purifiers.

**P02.2000. Associations between Infant Birth Weight and Seasonal Variations in PM2.5 Exposure during Pregnancy: A Prospective Cohort Study in a Rural Community in China**

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**Abstract:** Background: Exposure to PM2.5 (fine particulate matter) pollutants in pregnancy has generally been found to be associated with infant low birthweight. In rural China, exposure of pregnant women to PM2.5 from indoor coal or wood-burning heaters, stoves and second-hand smoke is expected to have seasonal variations that may have implications on the birth weight of the offspring. Methods: In a prospective pregnant woman cohort study, 380 pregnant women carried a Portable Particle Monitor to measure 24-hour individual exposure to PM2.5 over a period of 5-7 days at first (T1), second (T2) and third trimester (T3) time points. The questionnaires to women were conducted simultaneously. Newborn were weighted by standard scale at birth. Latent Variable Growth Curve Modeling was used to elucidate the effects of seasonal variation to PM2.5 exposure in the course of pregnancy on the birth weight. Four groups were compared based on the season when the mother was in first trimester. Results: The average PM2.5 exposure throughout pregnancy were 27.2, 26.3, 28.3, and 30.9  $\mu\text{g}/\text{m}^3$  in four groups (their first trimester in Spring, Summer, Autumn and Winter), respectively. Different groups revealed special associational patterns. Intercept factors were -25.8, -51.3, -27.0, and -43.1 for mothers in first semester in Spring, Summer, Autumn and Winter respectively and slope factors were 0.8, -3.7, 8.4, and 8.2, respectively. Mothers in first trimester in Summer had newborns with the lowest birth weight with an increase of one unit of PM2.5 exposure being associated with a decrease in 51.3g in birth weight. Conclusions: PM2.5 exposure was associated with low birth weight across all 4 groups. Mothers who were not exposed to winter had newborns with the highest birth weights. Increased exposure to PM2.5 in the cold seasons may cause the decrease of birth weight and was associated with low birth weight.

## **P02.2010. Risk of Respiratory Hospital Admissions in the Vicinities of Large-Scale Composting Facilities in England**

Aina Roca Barceló

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**Abstract:** Background Biological aerosols released in the air during decomposing of organic material have been associated with adverse respiratory health events. We aimed to investigate whether living in the vicinity of a large-scale composting facility is associated with adverse risks to respiratory health. Methods All large-scale composting facilities operating in England during 2005-2014 were geocoded (n=217). We estimated the distance between the population-weighted centroid of each census output area (COA) in England and the nearest composting facility. Only COAs within 4km of a composting facility were considered, excluding any COAs lying within 4km of more than one composting facility. Hospital admissions with a primary diagnosis of any respiratory condition (ICD-10: J00-J99), respiratory infections (ICD-10: J00-J22), asthma (ICD-10: J45-J46), COPD (ICD-10: J40-J44), and cystic fibrosis (ICD-10: E84), and whose residential postcode at time of admission fell within a study COA were analysed. We fitted a hierarchical Poisson regression model to assess association with hospital admission risk and distance to the nearest composting facility (continuous and quartiles), as proxy of exposure. We included a random intercept for each COA nested within a random slope for each composting facility to account for over-dispersion. Analyses were conducted combined and separately for each disease. Results We identified 17,489 COAs and a total of 475,849 unique hospital admissions with a primary diagnosis of a respiratory disease. We did not find any substantial increase in hospital admission risk by proximity to a composting facility for any of the diseases studied in any of the distance measures. Conclusion This national study does not provide consistent evidence of increased risk of respiratory hospital admissions in the vicinities of large-scale composting facilities. However, bio-aerosols have complex dispersion patterns thus, improved exposure assessment is required to inform policy.

## **P02.2030. Use of Integrated Urban Models to Assess Urban Sustainability and Health Impacts of Future Growth Policies in Canadian Cities**

Hanna Maoh

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**Abstract:** Background/Objectives: Public health and quality of life have been increasingly impacted by changes in land use and transportation. Integrated Urban Models (IUMs) support urban planning by simulating the impacts of such changes. To promote healthier cities, we need planning tools that consider sustainability and health outcomes. This study expanded the SmartPlans IUM simulation platform to produce a variety of environmental, social and economic indicators that could be used to evaluate the efficacy of alternate urban growth scenarios. SmartPlans was also expanded to evaluate the health benefits of simulated scenarios. Methods: A broad array of sustainability and health indicators was identified for incorporation in SmartPlans including 18 acute and chronic health endpoints. We obtained feedback from 128 stakeholders from academia, all levels of government organizations, and regional health authorities across Canada to support indicator selection. SmartPlans was also updated to produce concentrations of pollutants using Land Use Regression models. These concentrations, which are used in the calculations of the 18 health endpoints to evaluate health benefit outcomes, rely on the outputs of the land use and transportation modules of SmartPlans. Results: Input from stakeholders across Canada was incorporated into the final indicator selection and weighting. Simulation tests representing various land use and transportation scenarios with SmartPlans for Halifax, Nova Scotia and London, Ontario highlight the strengths of using SmartPlans to assess progress towards sustainability and health benefits. Simulations tests show the benefits of urban intensification over suburbanization. Discussion/Conclusions: This study demonstrates the utility of extending IUMs like SmartPlans to include sustainability and health indicators. SmartPlans can be used to support prioritization of environmental and health outcomes in urban decision-making and environmental planning.

## **P02.2040. Residential Proximity to Unconventional Oil and Gas Development and Air Volatile Organic Compound Concentrations in Ohio**

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**Abstract:** Approximately 4 million Americans live within one mile of an unconventional oil and gas (UO&G or "fracking") well, potentially placing them in the path of toxic air emissions. We conducted a community-based, exploratory study to evaluate associations between proximity to UO&G wells and presence of volatile organic compounds (VOCs) inside and outside 66 homes (n=132 samples) in Belmont County, Ohio, an area with an active UO&G industry. Well locations were obtained from the Ohio Department of Natural Resources. Passive charcoal badges were selected as low-cost samplers that could readily be deployed both indoors and outdoors over a one-week period. Samplers were used to collect indoor and outdoor air samples over approximately nine days and were analyzed for three VOCs using gas chromatography and flame ionization detection. Using multivariate logistic regression, we assessed relationships between inverse-distance-squared-weighted (ID2W) well counts and detection rates of benzene, ethylbenzene, and toluene. VOCs were generally not detectable in the outdoor air samples (detection rate  $\leq 3\%$ ); indoor detection rates were 23% for benzene, 14% for ethylbenzene, and 49% for toluene. Three homes had indoor and one home had outdoor benzene concentrations exceeding health-based references. No associations between ID2W well count and detection rates of benzene, ethylbenzene, and toluene in residential air samples were observed. Though we had a large proportion of samples below the detection limit and did not observe any correlations, this study is among the first to compare UO&G proximity metrics with indoor and outdoor home measurements of air pollutants. Use of more sensitive sampling methods are needed for future efforts. The inclusion of additional attributes of UO&G wells and local meteorological and topographical data into proximity models could provide further insights into the potential for increased residential exposures to VOCs in communities with UO&G operations.

**P02.2050. A Six Months Exposure Assessment of Ambient PM2.5 Concentration in Kampala, Uganda: Preliminary Results from the Eastern Africa Geohealth Hub**

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Abstract: Ambient air pollution remains a major public health threat. It causes morbidity and premature deaths worldwide. Annually, an estimate of 3 million deaths occurs as a result of exposure to ambient air pollutants like particulate matter, ozone, nitrogen dioxide and sulphur dioxide globally. Indoor and ambient air pollution is a major public health challenge for rural and urban areas in Uganda. More than 90% of households in Uganda depend on biomass fuel for cooking & lighting. Worse still, ambient air pollution is on the rise due to rapidly increasing use of vehicles, congestion, dirty fuels, industrial development-steel and rolling mills, cement factories, the recycling industry, and incinerators. We measured Ambient PM2.5 Concentration using the Beta Attenuation monitor (BAM) 1022, centrally installed in the Central Sub City of Kampala Capital City Authority, Makerere University School of Public Health roof top at height of 15 metres above the ground level. The BAM 1022 generates real time data for PM2.5, Relative Humidity, Ambient Temperature, and Barometric pressure. Data analysis was done using MS Excel 2016 to generate monthly mean PM2.5 concentrations for period sept 2017-Feb 2018. Our results showed the monthly average PM2.5 concentrations for the six months was 47 µg/m<sup>3</sup>. The lowest and highest monthly mean PM2.5 concentrations appeared in Oct 2017 (36.5 µg/m<sup>3</sup>) and Jan 2018 (69.2 µg/m<sup>3</sup>) respectively. There is notable rise in monthly mean PM2.5 concentrations from Dec 2017 (50.0 µg/m<sup>3</sup>), Jan 2018 (69.2 µg/m<sup>3</sup>) through Feb 2018 (54.3 µg/m<sup>3</sup>) There is observed increase in ambient air pollution levels. These results provide a genesis of findings for generating scientific evidence on air pollution exposure in Uganda. Besides, they will give long-term assessment needed to characterize air pollution levels for all seasons, related public health impacts, and influence policy.

**P02.2060. Effect of Ambient Air Pollution on Respiratory Health of Market Women at Agbogbloshie Food Market, Situated near a Large E-Waste Recycling Site in Accra, Ghana**

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**Abstract:** Background: E-waste recycling activities and vehicular traffic can both release a mixture of pollutants such as heavy metals dust, persistent organic pollutants (PCBs and dioxins), carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO) etc. into the ambient air, exposure of which could lead to a variety of adverse health effects including respiratory health. No study has looked at the respiratory health of market women at the Agbogbloshie market. Objectives: The aim of this study was to assess the effect of ambient air pollution on respiratory health of market women at the Agbogbloshie open food market, near the infamous e-waste recycling site. Methods: This cross-sectional study utilized cluster random sampling to recruit 45 market women, aged 45-81 years, after ethical approval had been sought from the Ministry of Health. Respiratory symptoms (self-reported) data was collected using a structured questionnaire, and lung function test done by spirometry to obtain indices Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV<sub>1</sub>) and FEV<sub>1</sub>/FVC. Hourly average measurements of PM<sub>10</sub>, PM<sub>2.5</sub> and CO<sub>2</sub> were taken using Met One Aerocet Comet 860 and Hobo CO<sub>2</sub> monitor respectively. Multiple regression analysis was used to test for association between pulmonary function indices, respiratory symptoms and alcohol use. Results: Respiratory symptoms were high among market women. Multivariate analysis of covariates showed the ff; increase in the frequency of wheezing and difficulty in breathing resulted in 0.081 (8.1%) and 0.133 (13.3%) reduction in lung function, (p=0.020), (p=0.024) respectively. Traders who were alcohol users had 0.122 (12.2%) reduction in lung function (adjusted). Daily PM<sub>10</sub>, PM<sub>2.5</sub> and CO<sub>2</sub> ranges were (492.41-1690.62), (72.09-168.84 µg/m<sup>3</sup>) and (3053.33-3635.22 ppm) respectively. Conclusion: Agbogbloshie market women have high prevalence of respiratory symptoms such as cough, colds, sore throat and repeated sneezing, and reduced pulmonary function indices.

## P02. Global Health, Environmental Health Disparities and Other Social Issues 2

### **P02.2070. Residential Segregation and Transportation-Related Air Pollution Exposure Disparities in United States Urban Areas, 2000-2010**

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**Abstract:** Background: Residential segregation has been proposed as a factor contributing to environmental health disparities by race-ethnicity in the United States (US). This study investigates relationships between residential segregation and transportation-related air pollution (TRAP) exposure disparities across US urban areas and over time. Methods: We combined estimates of a TRAP (nitrogen dioxide [NO<sub>2</sub>] annual average concentrations from a national regression model) with Census demographic data for urban areas in the contiguous United States (n= 481) in 2000 and 2010. We estimated two aspects of differences between race-ethnicity minorities and non-Hispanic whites: disparities in NO<sub>2</sub> air pollution exposure and segregation in residential location (dissimilarity index). We constructed linear regression models relating those two aspects (racial disparities in exposure; residential racial segregation), controlling for racial disparities in urbanicity, racial economic disparities, racial diversity, population, pollution, and region. Results: After controlling for other urban characteristics, residential segregation is positively associated (p<0.001) with racial disparity in NO<sub>2</sub> exposure in 2000 and in 2010, and change in residential segregation over time is positively associated (p<0.001) with change in racial disparity in NO<sub>2</sub> exposure (adjusted R<sup>2</sup>: 0.65 [2000], 0.66 [2010], 0.38 [change: 2000-2010]). Increasing segregation across the interquartile range (holding all other variables constant at mean value) is associated with a 30% (0.2 ppb) increase in racial disparity in NO<sub>2</sub> exposure in 2000 and a 40% (0.2 ppb) increase in 2010. Conclusions: Higher levels of racial segregation were associated with larger racial disparities in TRAP exposure in 2000 and in 2010. Larger reductions in segregation over time (2000 to 2010) were associated with larger reductions in racial disparities in TRAP exposure.

## **P02.2080. Household Air Pollution and Glycated Hemoglobin among Women in Honduras: Baseline Data from Two Seasons**

Bonnie Young

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**Abstract:** **OBJECTIVE:** Growing evidence suggests a link between air pollution and cardiometabolic diseases, such as diabetes, yet most data come from ambient air pollution studies. We evaluated the exposure-response associations between household air pollution from traditional, wood-burning cookstoves and glycated hemoglobin (HbA1c), an estimate of average blood glucose concentration over the past 3 months, among women in rural Honduras. **METHODS:** We assessed two time points at baseline (rainy and dry seasons) from an ongoing randomized trial among 231 women, for a total of 462 observations. Exposure to household air pollution included 24-hour gravimetric personal and kitchen fine particulate matter (PM<sub>2.5</sub>) concentrations. HbA1c was measured with the A1cNow+ kit. We used mixed-effects regression models adjusting for known risk factors, including age, household material wealth, physical activity, body mass index, and daily consumption of cereals (corn, grains, rice, and chip products), as well as season. **RESULTS:** Median 24-hour PM<sub>2.5</sub> concentrations were 83 (25th percentile: 51; 75th percentile: 141) µg/m<sup>3</sup> and 197 (25th percentile: 81; 75th percentile: 473) µg/m<sup>3</sup> for personal and kitchen measurements, respectively. Mean HbA1c estimates were the same for both seasons at 5.5% (Phase 1 standard deviation: 0.6, Phase 2 standard deviation: 0.7). After adjusting for relevant confounders, results were consistent with a null association. Season did not impact the effect estimates. **CONCLUSIONS:** While exposure to household air pollution has known detrimental health effects, our baseline cross-sectional results did not suggest an association with HbA1c; these results are inconsistent with limited evidence from ambient air pollution. The ongoing trial will evaluate household air pollution and cardiometabolic disease following a cleaner-burning cookstove intervention among the study population.

## **P02.2090. Establishing Potential Exposure Contrasts Associated with an LPG Gas Intervention in Biomass Using Homes: Results from Pilot Phase Activities for the HAPIN Trial in Tamil Nadu, India**

Sankar Sambandam

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**Abstract:** Background: The Household Air Pollution Intervention Network (HAPIN) trial is a multi-country effort to demonstrate effects of a LPG (liquefied petroleum gas) intervention on birthweight, child health and adult chronic disease. We provide results from pilot exposure assessments at the trial site in India. Methods: We assessed 48-hr personal fine particulate matter (PM<sub>2.5</sub>) concentrations and exposures in the two candidate districts (Villupuram and Nagapattinam) in Tamil Nadu, India. Using Enhanced Children's MicroPEM (ECM) monitors we measured (i) personal exposures of the primary cook (n=40) and an older adult women (n=40), as well as kitchen concentrations, in biomass or LPG using homes (with the two groups of women drawn from different sets of households) and (ii) reductions in personal exposures and kitchen concentrations among previously biomass-using pregnant women (n=40), following the provision of LPG fuel and stoves. Results: The mean 48-hour kitchen PM<sub>2.5</sub> concentrations were 374 ± 211 µg/m<sup>3</sup> in biomass-using homes (n=33), when compared to 82 ± 81 µg/m<sup>3</sup> in LPG using homes (n=27). The personal exposures were lower than kitchen concentrations but higher in biomass using homes (121 ± 167 µg/m<sup>3</sup>) when compared to LPG using homes (82 ± 34 µg/m<sup>3</sup>). Paired measurements, performed before and after the LPG intervention among previously biomass-using pregnant women, showed a sustained reduction of 93% in mean kitchen PM<sub>2.5</sub> concentrations (from 309 ± 279 µg/m<sup>3</sup> to 29 ± 12 µg/m<sup>3</sup>) and 78% in mean personal PM<sub>2.5</sub> exposures (from 140 ± 187 µg/m<sup>3</sup> to 30 ± 28 µg/m<sup>3</sup>). Post-intervention levels were consistently less than the World Health Organization (WHO) Interim-1 Target PM<sub>2.5</sub> Guideline (35 µg/m<sup>3</sup>). Outdoor concentrations indicated limited contributions from other ambient sources. Conclusions: The overall exposure contrast at the India site of the HAPIN trial is likely to be in the steepest part of known exposure-response relationships for multiple health endpoints and argues favorably for site and intervention selection.

## **P02.2100. Analysis of PM2.5 Exposure Trends in Indian State Capitals between 2015-16 - an Environmental Justice and Equity Perspective**

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**Abstract:** Introduction: Exposure to high levels of ambient particulate matter is a key risk factor for ill health in India with the Global burden of Disease ranking it the 3rd largest contributor to DALYs in 2016. Regulatory-grade monitoring, remains scarce outside a handful of major metropolitan centres, and this contributes to poor awareness of the scale and geography of the problem, and hampers documentation of health effects. It also contributes to a Delhi-centric approach to air pollution problem-solving, to the detriment of other parts of the country where exposure could be higher. Methods: We collected regulatory data on PM2.5 published by the Central Pollution Control Board for the years 2015-16 for all Indian State capitals. Annual and seasonal average PM2.5 was calculated for each city and region (South, West, Central, Indo-Gangetic Plain, and East). For periods where direct PM2.5 measurements were unavailable, station-specific or city-specific PM2.5/PM10 ratios were used to derive PM2.5 data. We also documented the number of stations per city and the data availability by station for all these state capitals. Results: Only one state capital (Aizawl) met WHO guidelines for annual average exposure, with 8 others meeting the more relaxed National Ambient Air Quality Standards. The central region registered the highest average PM2.5 levels, with little variation across seasons, compared with the IGP or other regions which exhibited strong seasonal variations in PM2.5 levels. The eastern region showed the lowest PM2.5 levels. Monitoring capacity and data availability across cities and regions varied greatly from. Conclusions: The Central Indian region has the highest exposure to ambient air pollution. In spite of it being a hub for the mining, power and steel industries, monitoring capacity in this region is scarce. Consequently, there is little discussion about the potential health impacts here. We believe this represents an environmental justice and equity issue.

## **P02.2120. Exploring Barriers and Practical Solutions for the Uptake and Use of Clean Cooking through Photovoice Methods: The LPG Adoption in Cameroon Evaluation (LACE) Studies**

Daniel Pope

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**Abstract:** Background: Each year up to 4 million people die prematurely from household air pollution due to domestic use of solid fuel, mainly in low and middle-income countries (LMICs). Liquefied Petroleum Gas (LPG) is an affordable, scalable, and widely available clean fuel that provides health and environmental benefits when used for household energy in LMICs. In Cameroon, where 70% of people rely on biomass for cooking, the Government aims to increase LPG use from < 20% to 58% by 2035. Few qualitative studies have explored households' perceptions of factors affecting LPG uptake. We conducted community-based participatory research using photovoice methods to explore factors influencing LPG uptake and sustained use in South-West Cameroon. Methods: Two groups of participants from rural (n=7) and peri-urban (n=8) areas photographed aspects of their lives which prevented/enabled LPG uptake in their communities. Individual interviews (n=15) and group discussions (n=5) explored participants' reflections on the issues photographed. We conducted thematic analysis using NVivo 10 software. Results: Main barriers included difficulty in affording the initial LPG equipment and ongoing refills, scarcity of LPG retail shops and safety concerns. Key enablers/solutions included (i) increasing awareness of the benefits of LPG, (ii) additional retail shops, (iii) addressing safety concerns, (iv) repairing roads to improve distribution, and (v) reducing the refill price. We organised an exhibition of participants' photos to generate discussions between participants and representatives from government, communities, industry and media about how to assist communities with fuel transition. Conclusions: Photovoice was found to be an effective participatory approach that (i) identified factors affecting uptake and use of LPG, which could be transferable to Sub-Saharan contexts, and (ii) engaged with participants and key stakeholders to identify how to advance equitable access to LPG in Cameroon.

**P02.2130. Characterizing Ambient Air Pollution Exposures, and the Biological Mechanisms Mediating the Associated Health Effects among Street Vendors in Accra (Biommaps Study): A Study Protocol**

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Abstract: Street vendors dominate the urban landscape of developing country cities with documented reports of high levels of air pollution (AP) exposures among these workers owing to the congested traffic in these cities. There is, however, limited evidence on the adverse health experiences of street vendors. Also, the exact biological mechanisms of respiratory and cardiovascular injury from exposure to AP have not been fully elucidated. In order to better understand the adverse health effects of AP exposure so as to tailor treatment and preventive strategies, it is important to establish the biological pathways. Genome-wide association studies have the capability of identifying novel genes and genetic polymorphisms in AP response phenotypes and consequently provide insight into the biological mechanisms underlying air pollution health effects. It is against this background that our aim is to characterize air pollution levels and the associated adverse health effects among street vendors in Accra, as well as elucidating the biological mechanisms mediating the associated adverse health effects. Longitudinal study of five-year duration will be conducted. Six hundred (600) street vendors permanently working at six traffic hotspots and 600 teachers teaching in schools in three affluent neighborhoods will be recruited and followed up every three months throughout the study period. Personal AP monitoring among 200 selected street vendors and 200 selected teachers will be undertaken once a week. Spirometric (FEV1, FVC and FEV1%), exhaled nitric oxide (eNO) and BP measurements will be taken at baseline and during each follow-up visit to assess lung function, endothelial function and onset of hypertension among the participants. Blood and sputum samples will be collected at baseline and every follow-up visit to measure levels of immunological markers of oxidative stress and inflammation, lipids, and to identify novel genes, explore polymorphisms and undertake gene expression.

**P02.2150. Indoor and Outdoor Residential Ammonia Concentrations in a Low-Income Cohort of Children with Asthma in an Area of Intensive Agricultural Production**

Anne Riederer

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Abstract: Ambient PM and NH<sub>3</sub> have been associated with measures of asthma health among children in rural Yakima Valley, Washington. Unlike PM, ammonia (NH<sub>3</sub>) has received little attention as a residential air contaminant of concern for children with asthma. We are conducting a randomized trial of a community-based asthma education program combined with home high efficiency air cleaners in 65 Yakima children (age 6-12 years) with poorly controlled asthma from nonsmoking homes located <800 m of dairy and/or crop operations. The HEPA air cleaner includes a pre-filter designed to reduce NH<sub>3</sub>. Two-week integrated NH<sub>3</sub> samples using Ogawa passive samplers are collected at baseline and follow-up from the child's sleeping area and home yard. Here we report the baseline (pre-randomization) NH<sub>3</sub> results. Geometric mean (GSD) NH<sub>3</sub> was 11.8 ug/m<sup>3</sup> (2.7 ug/m<sup>3</sup>) in the outdoor samples (n=65; max 97.6 ug/m<sup>3</sup>) and 67.5 ug/m<sup>3</sup> (1.8 ug/m<sup>3</sup>) in the bedroom samples (n=63), with 10 of these exceeding the batch-specific upper limit of quantitation. Indoor and outdoor concentrations were weakly but not statistically significantly correlated (Pearson rho=0.13, p=0.33). Indoor levels were statistically significantly (p<0.05) associated with the winter season but no other variables tested in bivariate and multivariable regression models. In a subset of children with data on NH<sub>3</sub> product use in the home, use of glass cleaner was statistically significantly associated with indoor NH<sub>3</sub> concentrations. Future work will explore the effectiveness of the HEPA cleaners at lowering indoor NH<sub>3</sub> levels in the study households.

## **P02.2160. Biomass Burning Health Effects on Brazilian Amazon Population**

Suzana Rodrigues

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**Abstract:** Forest fires occur frequently in the Brazilian Amazon and they are associated with increases of diseases among inhabitants. The aim of this study is to verify the presence of spatial autocorrelation between burns and hospitalizations due to respiratory diseases in children under 5 years and the elderly over 60 years, and cardiovascular diseases in adults between 30 and 59 years and elderly in the state of Mato Grosso. We analyzed the periods from January, 2003 to December, 2010 and January, 2011 to December, 2016. Univariate and bivariate analyzes of the Local Moran were performed on the incidence of hospitalizations by age groups and fires per area (square kilometer). Thematic maps were produced with formed clusters of incidence rates, stratified by age groups and diseases, and fires separately. The univariate thematic map of the incidences, for the first period showed that the areas at greatest risk was the northwest of the state; the fires formed an arc-shaped cluster in the north of the state. The bivariate thematic map of the hospitalizations in relation to the fires also showed the same tendency for the formation of the arch. For the second period, the results showed that the incidence, when analyzed alone, tends to form clusters in the Northwest region of the state. The burnings analyzed alone had the formation of clusters concentrated in the Northeast of the state. The bivariate clusters tended to concentrate in the Northeast region. The Moran analyzes was able to capture areas that are being deforested with the use of fire and, consequently, are causing health problems to the population. This study reinforces results found in the literature on the adverse health effects due to exposure to air pollutants generated by the burning of biomass in the Amazon region.

## **P02.2170. Assessment of Traditional and LPG Stove Use on Household Air Pollution and Personal Exposures in South West Cameroon**

Dan Pope

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**Abstract:** Introduction Cameroon has begun implementation of a national liquified petroleum gas (LPG) Master Plan to increase use of LPG from <20% to 58% of the population by 2030 to address the environmental and health impacts of reliance on solid fuel for domestic energy. The LPG Adoption in Cameroon Evaluation (LACE) studies assessed the potential impacts of replacing traditional solid cooking fuel with LPG on household air pollution (HAP) and personal exposures. Methods Samples of households (exclusive wood fuel (n=61) and primary LPG fuel (n=67)) from peri-urban and rural households in South West Cameroon were identified from LACE census surveys. PM<sub>2.5</sub> was measured over a 48-hr period using the RTI MicroPEM for kitchens (n=55; n=67), women cooks (n=61; n=67) and children (n=56; n=60). Stove-use-monitoring data, demographic and health surveys, and time activity diaries were collected alongside the exposure measurements. Results Kitchen PM<sub>2.5</sub> concentrations were significantly lower in households using LPG as their primary fuel compared to those using wood (geometric mean (GM) 23.7 vs 391.5 µg/m<sup>3</sup> p<0.0005). In addition, exposures in women (GM=14.5 vs 52.3 µg/m<sup>3</sup> p<0.0005) and children (GM=11.6 vs 29.9 µg/m<sup>3</sup> p<0.0005) were significantly lower in LPG households. Exclusive use of LPG was associated with the lowest levels of PM<sub>2.5</sub> for kitchens (exclusive =18.5 vs mixed=28.7 µg/m<sup>3</sup>), women (exclusive=13.3 vs mixed=15.9 µg/m<sup>3</sup>) and children (exclusive=11.1 vs mixed=12.0 µg/m<sup>3</sup>). Conclusion We measured significant reductions in mean PM<sub>2.5</sub> kitchen concentrations and personal exposure levels in households primarily using LPG when compared to those exclusively burning wood. Mean kitchen and personal PM<sub>2.5</sub> concentrations were lower than the annual WHO interim-target 1 guideline level of 35 µg/m<sup>3</sup>. These results show that a targeted effort to promote clean fuel adoption on a national level has the potential to significantly decrease HAP exposures of the most vulnerable populations.

## **P02.2180. Vent Pipe Emissions from Storage Tanks at Gas Stations: Implications for Setback Distances**

Markus Hilpert

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Abstract: At gas stations, fuel vapors are released to the atmosphere from storage tanks through vent pipes. Little is known about when releases occur, their magnitude, and their potential health consequences. Our goals were to quantify vent pipe releases and examine exceedance of short-term exposure limits to benzene around gas stations. At two US gas stations, we measured vent pipe flow rates and pressure in the storage tank headspace at high temporal resolution for three weeks. We modeled atmospheric benzene levels based on measured vent emission and meteorological data. For the two gas stations, average vent emission factors were 1.4 and 1.7 lb of gasoline per 1,000 gal dispensed. Modeling suggests that an 1-hour Reference Exposure Level for benzene for the general population (8 ppb) was exceeded 160 m away from the gas station. Under stable atmospheric conditions, an occupational 15-minute exposure limit for benzene (1 ppm) was exceeded 27 m downwind from the pipe due to the highest observed 15-minute vent release (6.6 kg of gasoline). Vent emission factors are more than 10 times higher than estimates used to derive setback distances for gas stations. Setback distances should be revisited and account for temporal variability in vent emissions.

**P02.2200. A Health Evaluation of Targeted Home Energy Efficiency Upgrades for Disadvantaged Residents in Dublin, Ireland.**

Paul Wilkinson

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**Abstract:** Background: There are numerous pathways by which home energy efficiency improvements may affect health. We are evaluating the Dublin "Warmth and Wellbeing" pilot scheme which is aimed at improving health, wellbeing and social inclusion through home energy efficiency improvements for people aged 55 and over living in fuel poverty and suffering from chronic respiratory disease. Methods: The evaluation has a controlled 'stepped-wedge' design in which homes of eligible participants receive energy efficiency upgrades at staggered intervals from April 2016 to March 2019. Participants are followed to the end of 2019. Principal outcome measures (measured before and after intervention) include: self-reported health and well-being scores (based on SF36, SGRQ, EQ-5D questionnaires); monitored changes in internal temperatures and indoor air pollutants; consultations and hospital admissions for exacerbations of respiratory illness; and prescription data for drugs used in the management of chronic airflow limitation (CAL) obtained from the Primary Care Reimbursement Service (PCRS). Results: To date (March 2018), 400 households of the target 1000 participants have been recruited, approximately half of whom have received energy efficiency upgrades based on healthcare worker assessment of their health and wellbeing needs. Initial analyses of baseline and post-intervention questionnaire data and month-by-month prescriptions data (for drugs under the Anatomical Classification System code R (CAL) and code J (antibiotics)) are in progress. Early indications suggest that required energy efficiency upgrades were much more substantial than originally expected. Conclusions: The Dublin Warmth and Wellbeing scheme is succeeding in implementing targeted home energy efficiency improvements for patients with chronic lung disease. The evaluation of this pilot will inform the possible expansion of the scheme in Ireland, and will be relevant to other similar settings.

## **P02.2210. Refresh the Air for Children Breath: Community Cooking Center is a Paramount Necessity among Climate Refugees in Dhaka**

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**Abstract:** Climate change is obvious and it will continue to change as a consequence of natural phenomena. Unlikely, geographical setting more frequent water-related climatic hazards (floods, cyclones) forced Bangladeshi poor's to become climate refugees and move to densely-populated-polluted city Dhaka. Keeping in view this problem statement, we compared and assessed different slum communities for Disability Adjusted Life Years (DALYs) lost due to asthma attack among children <5. Moreover, we also studied seasonal variations within these communities. According to pre-selection criteria one non-climate refugee and three climate refugee communities were selected by using different scientific & social techniques. A multifactor socio-epidemiological and environmental (SEE) approach was used to in-depth understand and assessed the effects of risk factors on children health. Household indoor air pollution (IAP) is one of the potential determinants to identify the impact on child health (i.e. asthma) and it is intrinsically linked with poverty. Biomass is the largest source of IAP in poor societies. Some of air quality parameters (CO, NO<sub>2</sub>, Dust-particle) were measured onsite and during each visit, asthma attack along-with breathability level were determined. The results showed that there is great difference between DALYs lost belonging climate refugee communities. Moreover, among climate refugees, mixed refugee community was the most vulnerable, showed DALYs loss of 70%. Besides, DALYs lost due to asthma demonstrated huge changes with odds ratio ranges of 3.4–5.8 in three consecutive seasons. The non-climate refugee community showed reasonably less in DALYs loss. Influencing factors, such as urban services, maternal illiteracy, fuel use, ventilation system and behaviors, strongly attenuated DALYs. Therefore, this study directed a strong link between community cooking center and increased child breathability in slums and highly recommended for policy makers in priority set up.

## **P02.2220. Neighborhood Socioeconomic Factors and Cardiovascular Disease: A Cluster Analysis in North Carolina**

Anne Weaver

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Abstract: Where we live contributes to how long and how well we live. Neighborhood-level socioeconomic status (SES) is associated with health outcomes, including cardiovascular disease (CVD) and diabetes, but these associations are rarely studied across large, diverse populations. We used Ward's Hierarchical clustering to define eight neighborhood SES clusters across North Carolina (NC) using 11 Census variables, including indicators of education, race, wealth, and urbanicity. Then, we assigned 6992 cardiac catheterization patients at Duke University to neighborhood clusters. We examined the associations between cluster and coronary artery disease index >23 (CAD) at the time of the index visit as determined by coronary catheterization, hypertension, and diabetes using logistic regression adjusted for age, race, sex, body mass index, and smoking status. Four clusters were urban, three were rural, and the referent cluster was suburban. Compared to the suburban cluster, an urban cluster with low SES and a large black population had 40% increased odds of hypertension (95% CI 1.07-1.85), while the highest SES urban cluster with a small non-white population had lower odds of diabetes (OR 0.72, 95% CI 0.57, 0.92). A rural cluster with low SES and a large black population had higher odds of all outcomes (OR for diabetes 1.25, 95% CI 1.03-1.53; for hypertension 1.28, 95% CI 1.05-1.56; for CAD 1.39, 95% CI 1.15-1.69). In addition, a rural cluster with low SES and a large American Indian population had increased odds of CAD (OR 1.70, 95% CI 1.20, 2.41). We observed differences in prevalence of CVD and diabetes across NC based on neighborhood characteristics. This study has implications for future studies among diverse populations and contributes to understanding of the total environment. This abstract does not necessarily reflect EPA policy.

## **P02.2230. Environmental Pollution, Mortality Rate and Hospital Admissions in Chilean Communes, 2015**

Macarena Valdes

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**Abstract:** Introduction Studies have described associations between psychological, cardiovascular, respiratory, and other chronic effects and environmental exposures at the individual level. Our aim is to explore the association of different types of environmental issues and health effects as mortality rate and hospital admissions at commune level. **Methods** An ecologic study focused on the comparison of the sex-age-adjusted mortality rate and hospital admission in 139 Chilean communes, 2015. The National Survey of Socioeconomic Characterization (CASEN) provided information about the report of environmental issues such as air/ odor pollution, water pollution, solid residues and plagues of households; these data were collapsed at commune level as a prevalence. Mortality and hospital admission data were acquired from public national databases; cause-specific rates were calculated for respiratory and circulatory mortality rate, and respiratory hospital admission. Robust negative binomial regression models were run to explore the effect of each environmental prevalence on health outcomes. **Results** The total, respiratory, and circulatory mortality rate in Chile in 2015 were 5.74, 5.52, and 1.57 per 1000 individuals respectively; total and respiratory hospital admission rate were 9.25 and 0.88 per 100 individuals. The mean of report proportion about air and odor pollution, river, and natural water sources pollution, public water sources pollution, solid residues pollution and plagues was 18%, 6%, 4%, 18%, and 26% respectively. There was an association between plague prevalence and total and respiratory mortality rate. **Conclusions** Plagues prevalence was positively correlated with the total and respiratory mortality rate at commune level; the rest of environmental issues were not correlated to health outcomes. However, it needs to improve the measurement of the exposure variable at the group level.

## **P02.2250. Prevalence of and Risk Factors for Chronic Kidney Disease of Unknown Aetiology in India**

Cristina O'Callaghan-Gordo

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**Abstract:** Background: Studies in central America and Sri Lanka have reported a high burden of chronic kidney disease of unknown aetiology (CKDu). It is unknown whether CKDu occurs in other regions of the world and what the risk factors are. Methods: We estimated the glomerular filtration rate (eGFR) and the prevalence of eGFR below 60ml/min per 1.73m<sup>2</sup> (eGFR<60) (a proxy definitions of CKDu) in 12,500 people without known risk factors for chronic kidney disease (diabetes or hypertension) or heavy proteinuria. Participants were enrolled in three population-based studies in urban and rural areas of Northern and Southern India between 2010-2014. Results: The mean eGFR was 105.0±17.8 ml/min per 1.73m<sup>2</sup>. The prevalence of eGFR<60 was 1.6% (95%CI=1.4-1.7), but this figure varied markedly between areas, being highest in rural areas of Southern Indian [4.8% (3.8-5.8)]. In Northern India, older age was the only risk factor associated with lower mean eGFR and eGFR<60 [regression coefficient (95%CI)=-0.94 (0.97 - 0.91); OR (95%CI)=1.10 (1.08-1.11)]. In Southern India, risk factors for lower mean eGFR and eGFR<60 were residence in a rural area [-7.78 (-8.69 - -6.86); 4.95 (2.61-9.39)], older age [-0.90 (-0.93 - -0.86); 1.06 (1.04-1.08)] and less education [-0.94 (-1.32 - -0.56); 0.67 (0.50-0.90) for each five years at school]. Conclusions: Reduced eGFR that is not associated with traditional risk factors for CKD is common in rural settings of Southern India. This is the first population-based evidence, using standardised methods, which indicates that CKDu is present in India and is not confined to central America and Sri Lanka.

## **P02.2260. Residential Built-Up Area in Relation to Markers of Cardiovascular Health in Peri-Urban South India**

Cathryn Tonne

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**Abstract:** Much of India is experiencing rapid urbanization in parallel with increases in non-communicable diseases, thus being an attractive setting to investigate the impact of urbanization on health. We investigated associations between contemporaneous built-up area and markers of cardiovascular health (blood pressure, fasting glucose, HDL cholesterol, and triglycerides) in the Andhra Pradesh Children and Parents Study (APCAPS) study. The study population included 5800 adults (53% male, mean age 36) living in the peri-urban area South East of Hyderabad, India. Health data were collected in 2010-2012 following standardised protocols. Three built-up indices were obtained from Landsat satellite imagery for year 2009: Impervious Surfaces, Urban Index, and Normalized Difference Built-up Index. We additionally conducted a random forest supervised classification algorithm. We derived mean exposure at residence of all 4 metrics using 100-m, 300-m, and 500-m circular buffers. We used sex-stratified mixed effects models to estimate the association between log-transformed health outcome and exposure metrics accounting for spatial clustering and confounders. The built-up metrics were strongly correlated and yielded similar results. In women, increased built-up area around residence was significantly associated with increased systolic and diastolic blood pressure (+0.8% [0.1-1.4] and +1.1% [0.3-2.0] per 6% increase in 300-m impervious surface, respectively) and increased triglycerides (+3.3% [0.9-5.8] per 7% increase in 500-m urban index). In men, corresponding associations were not significant. Residential built-up area was associated with modest increases in blood pressure and triglycerides in Indian women. On a population-scale, such increases could contribute to the increasing burden of cardiovascular diseases in India. Further work will investigate the role of potential mediators (including air pollution and lifestyle) of the observed associations.

## **P02.2270. Biomonitoring Study among People Living near Abandoned Metal Mines in Southern France**

Amandine Cochet

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**Abstract:** After more than 100 years of past industrial mining activity in the Gard department (Southern France), significant pollution of soils with lead, arsenic and cadmium has been observed. To better understand the exposure of neighboring populations, Santé publique France (the French Public Health Agency) conducted a population biomonitoring study. The objectives were to measure the biological exposure levels, to identify the key factors of exposure and to propose appropriate measures to reduce human exposure. The study took place in a sensitive context with significant media pressure. A cross-sectional study was conducted among the general population and participation was on a voluntary basis. Different data was collected: biological samples (blood for lead and urines for arsenic and cadmium), questionnaire on eating habits and lifestyles, environmental samples in soils and house dust. The levels of lead, arsenic and cadmium were quantified and a generalized linear model was used to determine the risk factors. Santé publique France relied on a multidisciplinary external advisor committee to translate the results into appropriate operational measures. The committee completed the process by interviewing various stakeholders (elected officials, local authorities, associations and residents' representatives). The participation rate was 23.5% (651/2774). Nearly a quarter had an over-exposure of arsenic and 13% of cadmium. Blood lead levels were not different from those observed in the French population. In addition to the expected key factors (age, sex, alcohol and tobacco consumption), biological levels were influenced by pollutant concentrations in soils and the consumption of certain local products. Pollutants in dust were not correlated with biological levels. However, the frequency of home cleaning was associated with a decrease in biological levels (lead, arsenic). Collective and individual proposals for exposure reduction were formulated.

**P02.2280. Investigation of Cadmium Exposure in Regards to Smoking Status and Moose and Caribou Organs Consumption in Northern Canada**

Brian Laird

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Abstract: Country food consumption among northern populations is associated with improved nutrition but occasionally can also increase contaminant exposure. Elevated cadmium levels in organs of moose harvested in the southern Mackenzie Mountains resulted in a food consumption notice by the Health and Social Services Department of the Northwest Territories, to recommend that people limit their consumption of liver and kidneys. Liver and kidneys of both moose and caribou are regularly consumed as country foods consumed in the Northwest Territories. The aim of this work is to report the levels and assess the determinants of cadmium exposures among communities of the Northwest Territories. The contaminants biomonitoring project includes dietary assessments (e.g. Food Frequency Questionnaire) and the collect of urine and blood samples. Participants were free to take part in any of the components of their choice (food questionnaires, hair/urine/blood sample). Cadmium was quantified using an inductively coupled plasma mass spectrometer (ICP-MS). The association between cadmium level, co-factors (age, sex) and potential sources (consumption of moose and caribou kidney and liver, smoking) were investigated. The 331 participants from the first 13 months of sample/data collection provided 144 blood and 127 urine samples. Participants who reported eating organs (liver, kidney) of moose and/or caribou did not have significantly higher cadmium levels. Instead, smoking status was significant determinant of cadmium levels in both blood ( $p < 0.001$ ) and urine ( $p = 0.006$ ). Results show cadmium levels similar to those observed in other populations in Canada. These results are supporting ongoing efforts to identify health priorities and plans in response to environmental monitoring data.

## **P02.2290. The Great (Cannbis) Smoke Out: Case-Only Analysis of Calls to a Canadian Poison Centre**

Tom Kosatsky

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Abstract: Each April 20 (4/20), thousands across North America celebrate cannabis use by attending public 4/20 events. Vancouver (BC, Canada) hosts around 40 000 celebrants. We assessed how callers to a poison centre on 4/20 differ from callers on other days of the year. We hypothesized that 4/20, would attract first-time or occasional cannabis users. We conducted a case-only analysis of BC Poison Centre call records from 2013-2016 to quantify the degree to which individual and situational factors modify the risk of a poison centre call about cannabis exposure on 4/20. Modifying factors considered included age, sex, cannabis formulation, caller location, and cannabis-use history. Data were extracted from poison centre records. We defined event cases as callers on 4/20 or the day after reporting cannabis exposure and comparison cases as those reporting cannabis exposures on other days of the year. Cases reporting the use of illicit substances other than cannabis were excluded. We identified 19 event and 721 comparison cases from 2013-2016. Univariate regression produced interaction odds ratios for a cannabis-exposure call on 4/20 among those with certain characteristics compared to those without. 4/20 callers were more likely to have consumed edible cannabis products than other formulations, and more often called from Vancouver itself than elsewhere in BC. Adjusting for location, the odds of being a 4/20 cannabis caller were 3.7 times higher among consumers of edible marijuana products (95% CI, 1.39-11.82). Surprisingly, 4/20 calls from first-time users or from children and teens were not more frequent. Results highlight concerns for edible cannabis products: delayed absorption contributes to users consuming successive servings of edible cannabis product while waiting for the drug's psychoactive effects to begin. 4/20 event messaging, product packaging, and health providers should warn users about the particular effects of edibles.

## **P02.2300. Ending Open Defecation: A Struggle to Evoke Behavioral Change**

Elizabeth Abba

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Abstract: Evolution of toilet, a significant chapter in the history of human civilization, is a link between life and health, society and environment. To promote Sustainable Development Goals and National Health Mission of India, eradication of Open Defecation(OD)is necessary. The present qualitative research study finds out causes which encourage and discourage people to adopt open defecation. A total of 36 households were selected from five villages in Puri district of Odisha, India. Only 30.56% of all the households studied had adopted use of toilets at homes. 27.88% did not have toilets and 41.67% were having toilets but not using them. 'Lack of funds' for construction, was reported as one of the prime reasons by 60% of households without toilets. Members of these households had no more than 5 years of education and believed that open defecation was healthier. They believed that it is inappropriate to defecate near kitchen or temple, as toilet brings bad odour and impurity. On the other hand, household members using toilets selected hygiene and women privacy as primary reasons. 73% of them fell within the education category of 'graduate' and 10-12 years of education. However, 82%, of them had toilet located outside the house for religious reasons. Hence poor economic condition, lack of knowledge, cultural practices, personal preference, poorly built GOI toilets, lack of access to water and family influence were found encourage OD. Decent income, education, awareness, women's safety, social status, privacy discouraged OD. Interviewees felt that small cramped structures of government subsidized toilets prevent their usage. Hence, we recommend latrine design, wherein toilet will be bigger than the standard, built at back of the house. It would lack a roof to allow sufficient ventilation and latrine pit will be surrounded by grass. Such a design will enable switching from the fields to the latrine pits. We also recommend Behavior Change Communication as an effective approach

## **P02.2310. Assessing the Evolution of Mortality in Spain during and after the Great Recession. a Spatio-Temporal Bayesian Multivariate Age-Period-Cohort Model**

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**Abstract:** Background: Although mortality from all causes in Spain already showed a decreasing trend before the Great Recession, during this there was an even greater reduction. Right after this, however, there was a change in trend, with a significant growth in mortality. Nevertheless, that time trend observed in the period scale may not be equal to the trend in the age or in the cohort scales. Objectives: Our main objective is to use Bayesian multivariate age-period-cohort (APC) models to assess the temporal trends of mortality in the three time scales and stratifying by sex, profession and region of residence of the deceased, in Spain in the period 1998-2014. Our second objective is to extend the Bayesian APC model in order to detect spatial clusters at the level of small areas. Methods: We have all the deaths occurred in Spanish cities of 20,000 inhabitants or more between 1998 and 2014 in each of the census tracks of the municipalities. We use Bayesian multivariate APC, stratifying by sex, profession and region of residence of the deceased. We include correlated overdispersion parameters and correlated smoothing priors, both across those strata. In addition, we extend the model to incorporate spatio-temporal heterogeneity in small area (census tracts) rates. Inference is made through the integrated nested Laplace approximation (INLA). Results: Our preliminary results show that time trends in all-cause mortality differ in the three scales (age, period, cohort). Temporal trends in the period scale differ for sex, with a decrease in the age-specific mortality rate from 2014 onwards in women and a significant increase in men. However, this growth only occurs in more precarious groups such as the unemployed, workers in the primary sector and unskilled workers. Conclusion: It is important to use APC models that capture significant cohort-based experiences and to take into account similar variables that act on the different time dimensions.

## **P02.2330. Identification of Vulnerable Communities with High Lead Exposures Residing in Michigan**

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Abstract: Lead exposure is associated with numerous harmful effects in children and adults, including adverse neurological, cardiovascular, kidney, developmental, and reproductive outcomes. Exposure to even small amounts of lead can be harmful to a child's developing brain, resulting in detrimental effects on IQ and behavior. Over the past 50 years, lead exposure for the US population has decreased, resulting in lowered blood lead levels. However, there are still likely to be vulnerable communities (i.e., those overburdened with few resources and disproportionately impacted by lead exposures) where significant sources of lead remain that need to be identified to prevent public health crises like those observed in Flint, Michigan and East Chicago, Illinois and Indiana. We obtained a blood lead dataset from the state of Michigan comprised of measurements from young children (average age ~7 years old) collected over 10 years totaling ~2.5 million data points. Each individual blood lead measurement was geocoded to determine if neighborhood clusters existed with high lead exposures. We used ARCMAP 10.3.1 ([Getis-Ord Gi\*] and Gluster and outlier analysis [Anselin Local Morans I]) to identify communities with high blood lead levels (hot spots) by weighing the number of people with high blood lead levels (e.g., 3.5 or 5 µg/dl) by population or total number of people for blood lead screening. Lead concentrations in air, soil, dust, and drinking water, as well as other potential contributors to lead exposure were analyzed with blood lead data, including house age, environmental justice indices, census data, and major roads with traffic information. Preliminary results showed census tract clusters with high percentages of elevated blood lead concentrations that are related to lead concentrations in soil and dust, house age, environmental justice indices and other factors. These findings are important to target highly vulnerable communities to reduce the risk of lead exposure.

## **P02.2340. Mercury Levels in Women and Children from Suriname**

Jeffrey Wickliffe

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**Abstract:** Background: Small-scale, artisanal gold mining in Suriname frequently uses mercury to collect gold from sediment/soil slurries. Much of the mercury used in this process ends up in the surrounding watersheds including fish that inhabit these areas. Locally harvested fish are a staple source of protein for many communities in the interior areas of Suriname. There is concern that women and children in certain interior areas and possibly others (e.g. the capital Paramaribo) may be exposed to unacceptably high levels of mercury. Methodology: Hair samples were collected from women and children in 5 villages in the interior of Suriname. These included 3 villages within the primary gold-mining area and 2 villages upstream of the gold-mining operations. Collection and analysis of these samples was supported in part by our GEOHealth planning award. Hair samples have also been collected from women in the capital of Suriname, Paramaribo. Blood samples are also being collected from women in Paramaribo and several interior villages. Results: Women and children from the interior villages had hair mercury levels that were on average 2-2.5X (range of 1.6-5.6 µg/g) the concentration used by the USEPA as an actionable level (1.1 µg/g) considered to be of health concern. Women from Paramaribo had hair mercury levels that were on average 0.5X that of the action level used by the USEPA, however 26% still had hair mercury levels above this action level. Conclusion: Mercury in hair samples from women and children primarily in interior areas of Suriname are quite similar to those found in previous cohort studies documenting negative neurodevelopmental impacts on children that have been prenatally exposed. Additional research underway will help determine if there are any neurodevelopmental effects resulting from such exposures in these culturally diverse and unique communities in comparison to those that have been examined in previous work.

**P02.2350. Explaining Mercury Levels in Pristine and Gold Mining Impacted Aquatic Ecosystems of Suriname (South America)**

Paul Ouboter

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Abstract: Since 1985 a new gold rush has hit the eastern part of Suriname. Small-scale gold miners use mercury to amalgamate the gold. An estimated 40,000-200,000 kg of mercury is released into the environment annually. Measurements of total mercury in water, bottom sediment and fish in 53 localities spread all over Suriname showed high pollution levels in gold mining areas, but also in pristine Central and Western Suriname. The average mercury level in bottom sediment surpassed the Canadian standard for sediment in most localities, except the coastal plains. Of the predatory fish, 41 % had a mercury level above the European Union standard for human consumption. Core samples in floodplains showed a higher mercury level in the layers near the surface, indicating a recent anthropogenic source. High mercury levels in pristine areas can be explained by mercury being emitted and evaporated to the atmosphere in the mining areas, transported to the south-west by the prevailing north-eastern trade winds, and partly deposited in Central and Western Suriname, especially in areas with high precipitation. We hypothesize that a second mechanism is likely to impact the biological availability of mercury in the aquatic environment: mercury is easily bound to small sediment particles. Streams in mining areas are usually very turbid as a result of the mining activities. Part of the mercury released in these streams will bind to the suspended sediment. These sediment-mercury particles are too large to pass through biological membranes and are therefore less biologically available. This mechanism does not apply to pristine streams where turbidity is usually at a lower level. This could explain the significantly higher mercury levels in predatory fish in pristine streams compared to streams in gold mining areas. Mercury pollution in Suriname is causing elevated levels in the human population, with the highest values measured thus far being registered in a village far upstream of any gold mining.

## **P02.2360. Toxic Metals Exposure Biomarkers among Children Living near Battery Recycling Industry**

Shohreh Farzan

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**Abstract:** The last active lead-acid battery recycler located west of the Mississippi River is located in a low-income, primarily Hispanic community in eastern Los Angeles County. This secondary lead smelter processes millions of spent automotive batteries per year and community members have raised concerns about residential exposure pathways and the resulting public health threat. Battery recycling operations are notoriously associated with airborne and suspended dust releases of toxic metals, including lead (Pb), arsenic (As), cadmium (Cd), and antimony (Sb), which frequently exceed air quality standards. Initial screening of soil samples found concentrations of Pb, Cd, and As 30, 400, and 500 times higher, respectively, than California residential soil health-based standards. In collaboration with a local environmental justice organization, we developed a community-engaged study to characterize individual biomarkers of toxic metal exposures among children living in the communities adjacent (within 2.5 miles) to the smelter. Initial analyses of urine and toenail samples suggest that exposures among children may vary widely. In preliminary analysis of children's toenail samples, we detected a range of toxic metals levels, including As (Mean, SD, range= 0.28 µg/g, 0.24, 0.08-1.43); Pb (0.93 µg/g, 0.85, 0.07-3.83); Sb (0.19 µg/g, 0.19, 0.02-1.06). Using factor analysis, we observed that exposure to several metals of concern, including Pb, As, Cd, appeared to co-occur with Sb, which is thought to be a marker of secondary lead smelter emissions, suggesting that children are likely exposed multiple metals in combination. While toenails have yet to be fully characterized as a biomarker of metals exposure in relevant reference populations, these preliminary results indicate that children living near an active smelter in east Los Angeles county demonstrated variation in their exposure to combinations of metals, with some children potentially falling into exposure ranges of concern.

## **P02.2380. Heavy Metal Levels and Stunting in Healthy Ugandan Children**

Emily Moody

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**Abstract:** Introduction: The industrial transition of the past decades has increased the burden of toxic pollution in many low-income countries. Children growing up in these countries now face potentially high exposures to increasingly complex mixtures of metals. Methods: We recruited 100 healthy children between 6 and 59 months old who reside in the Katanga urban settlement in Kampala, Uganda, near Mulago Hospital. After recruitment, participants were accompanied to Mulago Hospital for a physical exam, blood sample collection, and environmental questionnaire. Results: Mean age was 27.9 mos (range 6-59 mos). 53% were male. Average height-for-age z-score (HAZ) was -0.73 (sd=1.8), and 23% were stunted (HAZ more than 2 SD below the WHO growth standard mean). We measured blood levels of 13 heavy metals (antimony, arsenic (As), barium, cadmium, cesium (Cs), chromium (Cr), cobalt, copper, lead (Pb), manganese, nickel, selenium (Se), and zinc) in all participants. A multivariable linear regression model to predict HAZ included the 13 metals and was adjusted for age, sex, hemoglobin, maternal educational level, and food security. There were significant negative associations between HAZ and chromium, arsenic, and lead, and significant positive associations between HAZ and cesium and selenium. The adjusted R<sup>2</sup> was 0.229 (p<0.001). Individual effect estimates for the five metals that were significant in our model were as follows (beta, std. error, p-value): As (-3.71, 1.52, 0.018), Cr (-1.60, 0.45, 0.0007), Pb (-0.15, 0.086, 0.095), Cs (1.85, 0.83, 0.0304), Se (0.013, 0.0074, 0.077). Conclusions: We found that stunting was prevalent in Ugandan pre-school-aged children and that higher blood levels of As, Cr, and Pb were associated with lower HAZ scores. Metal remediation and further work to identify important sources are potential intervention points to improve linear growth and developmental outcomes in this population.

**P02.2390. Identifying Environmental Sources of Metal Mixtures in Bangladesh: A Pilot Study from the Health Effects of Arsenic Longitudinal Study (HEALS)**

Tiffany Sanchez

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**Abstract:** Introduction: Environmental exposure to metals is pervasive and occurs across multiple sources. The Health Effects of Arsenic Longitudinal Study (HEALS) is an ongoing prospective cohort study predominantly focused on understanding health effects associated with arsenic exposure from drinking water. The goal of this project was to measure multiple metals in urine in order to better understand potential exposure patterns and to identify common environmental sources of exposure among this rural Bangaldeshi population. Methods: In a random sample of 199 adult HEALS participants (50% female), we used principal component analysis (PCA) with varimax normalized rotations, and hierarchical cluster analysis (CA), using Ward's method with Euclidean distances, to evaluate 15 urinary metals (As, Ba, Cd, Co, Cs, Cu, Mn, Mo, Ni, Pb, Se, Sr, Tl, W, Zn) and to assess commonalities with sociodemographic characteristics and potential sources of exposure. Results: PCA and CA showed similar patterns, suggesting 6 distinct principal components (PC)/clusters: Sr-Ni-Cs/Sr-Ni-Co; Pb-Tl/Pb-Tl-Se-Cs; As-Mo-W/As-Mo-W; Ba-Mn/Ba-Mn; Cu-Zn/Cu-Zn; and Cd/Cd. There was a strong significant association between the As-Mo-W PC/cluster and water arsenic levels ( $p < 0.001$ ). The Sr-Ni-Cs/Sr-Ni-Co PC/cluster was not related to any of the sociodemographic characteristics investigated, including smoking status and occupation. The Sr-Ni-Cs was the first PC and explained 21% of the variability. The As-Mo-W was the third PC and explained 12.5% of the variability. Day laborers appeared to have the highest exposure. Conclusions: The As-Mo-W cluster supports that groundwater is an important environmental source of metals exposure. There was one cluster (Sr-Ni-Cs/Sr-Ni-Co) for which we were unable to identify a source. Based on prior evidence and the lack of association to any sociodemographic variable, this cluster may be related to air pollution but future air sampling is necessary to confirm these findings.

**P02.2400. Pesticide Knowledge, Attitude, and Practice in the Study of Asian Women, their Offspring's Development and Environmental Exposures: The Sawasdee Birth Cohort Study in Northern Thailand**

Brittney Baumert

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Abstract: The use of pesticides for crop production has grown in developing nations, especially in Thailand. As a result, agricultural workers are exposed to higher concentrations of organophosphate and pyrethroid insecticides than other developed nations. The Study of Asian Women and Offspring's Development and Environmental Exposures (SAWASDEE) is a maternal occupational exposure study focused on analyzing maternal pesticide exposure and neurodevelopment in the children. We will enroll 300 pregnant women from the Chom Thong and Fang regions; these two regions are to be indicative of chronic and acute exposure. For this analysis, we focused on evaluating the pesticide knowledge, attitudes, and practices (KAPs) among participants. Of all individuals enrolled (N=134), 27% reported receiving training about pesticides. Significant associations were observed between an individual's knowledge of potential harm to the fetus from spraying pesticide in their homes and their educational attainment ( $p=0.006$ , Fisher's exact test) as well as the region they live in ( $p=0.03$ , Fisher's exact test). Educational attainment was also associated with overall understanding of the purpose for pesticides including whether pesticides protect people from pest-related diseases ( $p=0.039$ , Fisher's exact test). Women who had at least some high school education had the strongest attitude or perceived risk of pesticides. Individuals appeared to understand potential illnesses related to pesticide exposure but do not have a clear understanding of the idea of vulnerable populations. In analyzing the organophosphate and pyrethroid biomarker data, we will need to consider these differences. The findings of this analysis suggest the need to educate agricultural workers to mitigate risk. Furthermore, our results warrant further investigation of knowledge, attitudes, and perceived risks in the context of biomarkers of pesticide exposures.

## **P02.2410. Maternal Methylmercury Exposure through Rice Ingestion and Offspring Neurodevelopment in Rural China: A Prospective Cohort Study**

Sarah Rothenberg

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**Abstract:** Background: Dietary methylmercury intake can occur not only through fish ingestion but also through rice ingestion; however, rice does not contain the same beneficial nutrients as fish. In rural China, where rice is a staple food, associations between prenatal methylmercury exposure and offspring neurodevelopment were investigated. Methods: 398 mothers living in Daxin, China were recruited at parturition, and had a hair sample collected. Hair total mercury concentrations were measured as a proxy for methylmercury exposure. Mothers completed a semi-quantitative food frequency questionnaire, including rice and fish ingestion. Children were assessed at 12 months (n=270, 68%) and 36 months (n=197, 49%) using the Bayley Scales of Infant Development-II, yielding age-adjusted scores for the Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI). Multivariable regression was used to model log-transformed hair mercury with outcomes, adjusting for potential confounders, including fish and rice intake. Results: Among 398 mothers, 86% ingested rice daily, 43% never ate fish, and 11% ingested fish >twice/week. Maternal hair mercury averaged 0.48 mcg/g (median: 0.40 mcg/g). At 12 months, in adjusted models, a doubling in hair mercury corresponded to a 1.5-point decrease in the MDI (95% CI: -2.9, -0.03), while a doubling in hair mercury was associated with a 0.82-point decrease in the PDI (95% CI: -2.5, 0.86). At 36 months, in adjusted models, confidence intervals were wide for both MDI and PDI. A doubling in hair mercury corresponded to a 0.32-point decrease in the MDI (95% CI: -2.1, 1.5), and a 1.0-point decrease in the PDI (95% CI: -3.3, 1.3). Conclusions: For 12-month old children from rural China, prenatal methylmercury exposure was associated with statistically significant decrements in cognition; however, this association attenuated over time and was diminished and no longer statistically significant at 36 months. Funding: NIEHS R15ES022409 R21ES026412

## **P02.2420. The Organophosphate Pesticides in Meconium of Neonates Living in Agricultural Areas in Thailand**

Pornpimol Kongtip

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Abstract: Organophosphate pesticides are commonly used in Thailand and exposure represents a major risk during pregnancy. Prenatal concentrations of maternal urinary organophosphate metabolites were associated with infant cognitive and motor development. This study measures organophosphate pesticide in 68 meconium samples of neonates delivered from mothers living in agricultural areas in Thailand. Meconium samples were collected from neonates by nurses and kept at -45°C. The meconium samples were dissolved in deionized water and extracted with acetonitrile, cleaned up with QuEChERS technique and analyzed using gas chromatography mass spectrometry (GC-MS). The recovery of 10 organophosphate pesticides were ranged from 97.2 to 101.1% with relative standard deviation of less than 4%. The detection limits of the organophosphate pesticides ranged from 0.02-0.48 µg/g. The average age of mothers was 25.7 years old; 41% graduated at primary and secondary school. Their occupations were 33.8% agriculturist, 21.2% house wife, 18.2% general employee, 9.1% own business, 17.7% other. The result found organophosphates residue in 98.8% of meconium samples; they were 38.2% dichlorvos, 32.4% omethoate, 73.5% demeton-s-methyl, 50.0% dimethoate, 44.1% tolclofos-methyl, 50.0% malathion, 32.4% chlorpyrifos and 11.8% ethion. The median(range) of organophosphate pesticides detected were 0.67( 0.6-70.3) µg/g of dichlorvos, 5.6 (2.8-10.2) µg/g of omethoate, 0.4(0.2-0.8) µg/g of demeton-s-methyl, 0.4(0.03-26.6) µg/g of dimethoate, 0.08(0.01-0.21) µg/g of tolclofos-methyl, 0.28 (0.01-1.27) µg/g of malathion, 0.09 (0.02-0.39) µg/g of Chlorpyrifos, 0.21 (0.19-0.39) µg/g of chlorpyrifos. The pirimiphos-methyl and pyrazophos were not detected. The results found many organophosphate pesticides residue in meconium of neonates which was accumulated in fetus since the third month of pregnancy. The effect of these organophosphate pesticides residue could have effects on neurodevelopment of these babies.

**P02.2430. Association between Hepatic Index and Urinary Thiodiglycolic Acid in Residents Living near to a Big Petrochemical Complex**

Chang-Chuan Chan

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Abstract: Background/Aim No.6 Naphtha Cracking Complex in Taiwan is producing vinyl chloride monomer (VCM) and polyvinyl chloride (PVC) by Ethylene dichloride (EDC), which might release trace level of VCM and EDC in the atmosphere. Both VCM and EDC can also cause liver damage and lead to liver fibrosis or cirrhosis. The study is to estimate the exposure level of VCM and EDC with urinary thiodiglycolic acid (TdGA) as biomarker to evaluate the liver damage by VCM among residents nearby this big petrochemical industry. Methods Urine and blood samples and life style questionnaire from 771 participants were collected during 2016 in Dacheng and Zhutang Townships, South Changhua, Taiwan. The TdGA level in urine samples are analyzed by LC-MSMS with the adjustment of creatinine. Subjects who takes Vitamin B complex and has hepatitis B or C virus infection would be excluded. Fibrosis-4 (FIB-4) was utilized to evaluate the liver damage by VCM and EDC. The multiple regression was conducted to assess the relationship between urinary TdGA and the non-invasive index of FIB-4. Results In Dacheng Township, the near township to the industry, subjects were with significantly higher TdGA level of 292.1 µg/g creatinine and FIB-4 of 1.55 when compared to those in subjects in Zhutang Township, the far township to the industry. In the liner regression model, it showed the urinary TdGA levels and the distance to industry of subjects were significantly associated with the FIB-4 levels after adjusting potential confounders. To further identify the liver damage by FIB-4 level higher than 1.45, the logistic regression model also showed the urinary TdGA levels and the distance to industry of subjects were significantly associated with the liver damage after adjusting potential confounders. Conclusion Subjects with increasing level of urinary TdGA and living near to the VCM/PVC factory of the petrochemical industry lead to worse liver damage.

## **P02.2440. Biomonitoring of Exposure to Great Lakes Contaminants in New York State Burmese Refugees: Cadmium, Lead, and Mercury**

Sanghamitra Savadatti

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**Abstract:** The New York State Department of Health conducted a biomonitoring study to assess exposure to Great Lakes contaminants among susceptible populations living in western New York State. In 2013, Burmese refugee participants (n=206) aged 18 and older living in Buffalo, NY who ate fish caught from the Great Lakes Basin provided blood samples and completed a detailed questionnaire. This analysis focuses on assessing blood cadmium (Cd), lead (Pb), and mercury (Hg) concentrations among these participants and their association with local fish consumption. The geometric mean for Cd, Pb, and Hg were: 0.72 µg/L (95% CI, 0.66-0.79), 3.13 µg/dL (2.92-3.34), and 3.66 µg/L (3.36-3.98), respectively. The geometric mean for all three metals was at least twice as high as the general adult US population [Cd: 0.30 µg/L (95% CI, 0.28-0.32); Pb: 0.97 µg/dL (0.92-1.0); Hg: 0.81 µg/L (0.74-0.90)]. Multiple linear regression was used to identify important predictors related to blood Hg, Cd, and Pb concentrations. Potential predictors included demographics, lifestyle factors, and fish consumption parameters. Hg concentrations were elevated 1.4 (1.1-1.9) times in participants who reported consuming fish/shellfish within the past three days compared to those who reported no consumption in the past week. Ethnic/tribal affiliation (Burman, Karenni, Karen and "Other") was associated with blood Hg concentrations. The Karenni, who tended to consume less fish and fish paste, had significantly lower blood Hg levels. Cd and Pb levels were associated with frequent fish paste consumption and current smoking. In conclusion, consumption of locally caught fish and fish paste may result in an increase in blood levels of Cd, Pb, and Hg. Additionally, survey results identified a low awareness of local fish consumption advisories indicating an ongoing need to provide culturally sensitive fish consumption outreach and education targeted to this population.

**P02.2450. Reliability and Factor Validity of Two Screening Test (Clock and Frontal Assessment Battery [FAB]) of Neuropsychological Effects on Exposed Agricultural Workers from Maule, Chile**

Boris Lucero

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Abstract: In recent decades, great attention has been given to the development and application of tests that evaluate the neurobehavioral and cognitive effects of exposure to neurotoxic substances such as pesticides, especially in the occupational field. Experts have stressed that it is necessary to apply tests in a context of test and re-test or health surveillance, in order to establish early monitoring in occupational populations regarding the neurotoxic effect. Thus, it is necessary to test assessment instruments that could be utilized as "screening" measures on exposed population. The purpose of this work is to evaluate two test of pen and paper (Clock and Frontal assessment Battery [FAB]) with regard to their reliability (test-retest stability) and factor validity on a preliminary sample (N=65) of agricultural workers and pesticide applicators from Maule Region of Chile. The analysis shows that there is a test re-test strong positive correlation for the Clock Test ( $\rho = 0.609$ ,  $p = 0.01$ ) and a moderate correlation for the FAB ( $\rho = 0.404$ ,  $p = 0.01$ ). The analysis of the two test altogether showed a good consistency ( $\alpha = 0.53$ ) and between the two retest a high consistency ( $\alpha = 0.83$ ). The factor analysis showed one significant component that explains 60% of the variance. The results of this preliminary work show that these simple and economy tests present strong psychometric properties for its use as screening measures with farmworkers and pesticide applicators.

## **P02.2460. Urinary Inorganic Arsenic Concentration and Attention Deficit-Hyperactivity Disorder:**

### **A Population-Based Analysis in Arica, Chile**

Maria Munoz

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**Abstract:** Introduction: Arsenic has been identified as a risk factor for cognitive performance in children; however, the relationship with child behavior has been little studied. The aim of this study was to explore the association between arsenic concentration in urine and attention deficit-hyperactivity disorder. Methods: Data analysis of 2.538 individuals under the age of 15, users of the Environmental Health Center between 2009 to 2015. Outcome variable: Attention deficit-hyperactivity disorder deficit diagnosis obtains by nurse and/or doctor record. Exposure variable: Urinary inorganic arsenic concentration. Multiple regression models were used. Results: Complete information was obtained from 1.976 children (22% lost data). Mean age was 9 and 50.2% were women. The median of inorganic arsenic was 16.9 mg/L (p25-p75 8-27mg/L). The prevalence of attention deficit, hyperactivity and attention deficit hyperactivity disorder (ADHD) was 10%, 9% and 7% respectively. The adjusted model for age and sex revealed modest association between inorganic arsenic and attention deficit (OR: 1.009, CI95% 1.002-1.015), hyperactivity (OR: 1.009, CI95% 1.002-1.016) y ADHD (OR: 1.01, CI95% 1.002-1.018). Conclusion: Arsenic is considered as neurotoxic and the results of this exploratory analysis show an association; however, due limitation such as the method of obtains diagnoses, the lack of complete information and the absence of other co-variables, the results should be considered with prudence.

## **P02.2470. Association of Early Life Arsenic Exposure with Prehypertension in Adolescents and Young Adults in Rural Bangladesh**

Md Alfazal Khan

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**Abstract:** Background: Evidence suggests that prolonged exposure to arsenic through drinking water increases the risk of hypertension in adults. However, few studies have evaluated the impact of early life arsenic exposure on blood pressure in adolescents and young adults. This study aimed to assess the association between in-utero-and-childhood arsenic exposure and prehypertension among the participants aged 11 to 22 years. Methods: The study was conducted in rural Bangladesh, Matlab. A cohort of 200 adolescents and young adults were enrolled of which 107 had in utero and first five years exposure to water arsenic concentration over 400µg/L (exposed group) and 93 had less than 10 µg/L(unexposed group). Blood pressure was measured using a standard mercury sphygmomanometer with an appropriately sized cuff. Prehypertension in adolescents was defined as systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) between the 90th and 95th percentile for age, sex and height. For the subjects 18 years and above, prehypertension was defined as SBP ranging from 120-139 mmHg and/or DBP 80-89 mmHg. Results: The overall prevalence of prehypertension was 16.5%. The high exposure group had a higher prevalence of prehypertension compared to the low exposure group (20.6% vs. 11.8%, 1-tailed p = 0.049). After adjustment for potential confounders, the prevalence odds ratio (POR) for prehypertension was 2.3 [95% Confidence Interval (CI): 0.78-7.1, 1-tailed p=0.066] in the participants exposed to arsenic >400 µg/L in their early life. The increased prevalence of prehypertension was only evident in females (POR=8.8, 95% CI: 1.05-74.1, 1-tailed p=0.023), and not in males (POR= 1.1, 95% CI: 0.26-5.1, 1-tailed p=0.433). Conclusions: Our result suggests a possible effect of early life arsenic exposure on increased risk of prehypertension in females. We plan to follow this unique cohort to see if the effect on blood pressure persists in females as they grow older.

## **P02.2491. Groundwater Arsenic and Fasting Blood Glucose in the Context of Other Groundwater Chemicals: A Cross-Sectional Study in Bangladesh**

Matthew Gribble

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**Abstract:** Goal: To evaluate the association between groundwater arsenic (As) and fasting blood glucose (FBG), in the context of other groundwater chemicals, in Bangladesh. Methods: FBG and demographics were measured among adults  $\geq 35$  years of age ( $n=6,587$ ) participating in the Bangladesh Demographic and Health Survey (BDHS) 2011. Groundwater chemicals in 3,534 well water samples were measured in the British Geological Survey (BGS) and Department of Public Health Engineering (DPHE) 1998-99 survey. In this analysis, we assigned the nearest BGS-DPHE well's chemical exposure to each BDHS participant. Survey-estimation linear regression methods were used to model log-transformed FBG, among those using groundwater as primary drinking-water source, as a function of groundwater As, adjusting for age, sex, BMI, smoking status, diabetes medication use, region, rural or urban residence, household wealth, and educational attainment. We considered interactions of As with 14 other groundwater chemicals. Results: Compared to persons exposed to groundwater As  $< 10$  mg/L, the geometric mean ratio (GMR) of FBG was 1.01 (95% confidence interval: 0.98, 1.04) for individuals exposed to groundwater As concentrations  $\geq 10$  mg/L and  $< 50$  mg/L, and was 1.01 (0.97, 1.03) for those with  $\geq 50$  mg/L water As. Low K water may have potentiated As toxicity: Among persons with low water K, the GMR of FBG for the  $\geq 10$  and  $< 50$  As range vs.  $< 10$  mg/L was 1.03 (1.00, 1.07), and for  $\geq 50$  vs.  $< 10$  mg/L was 1.06 (1.01, 1.11). Persons with low Ca and persons with low Mg also had higher GMR of FBG in the  $\geq 10$  and  $< 50$  mg/L As group vs.  $< 10$  mg/L As. However, after Bonferroni correction no associations were significant. Conclusions: We did not detect an overall association between As and FBG. This may be due to exposure misclassification. It is possible that low groundwater K, Ca, or Mg exacerbated As toxicity to detectable levels despite exposure misclassification, but these could be false positives from multiple testing.

## P02. Prenatal and Early Life Exposures and Effects 2

### **P02.2510. Alteration of Microbiome in Colostrum and Infant Health Risks from Exposure to HCHs in Mother-Infant Pairs**

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Abstract: Hexachlorocyclohexane (HCHs) are a kind of persistent organic pollutants (POPs), which are persistent, bioaccumulated and endocrine-disrupting. Infants are sensitive population for POPs and easily to be affected by dietary intake of POPs and the microbes in colostrum. This study was conducted to measure the exposure levels of HCHs in colostrum of mothers living on the island facing interchange of the Yangtze River mouth and Qiantang River mouth where were highly polluted in China, evaluate the HCHs exposure risks of newborns from dietary intake of colostrum, analyze the microbial diversity in 30 selected colostrum samples, and assess the potential effects from exposure to HCH on microbial diversity in colostrum. The concentration of  $\gamma$ -HCH was the highest of three HCH components in colostrum. When compared the total daily intake (TDI) of HCHs from colostrum with reference dose (RfD) standards, 56.7% newborns exceeded  $\gamma$ -HCH standard. *Pseudomonas*, *Enterococcus*, *Acinetobacter* and *Stenotrophomonas* were predominant bacterial genus in colostrum samples. Compared with the group with low  $\gamma$ -HCH concentration, relative abundance of *pseudomonas* in the high exposure group is significantly higher. Our findings suggested that exposure to HCHs due to environmental contamination might contribute to changes of microbial diversity in colostrum and dietary intake of HCHs in colostrum has potential health risks on newborns living in this area.

## **P02.2520. Associations of Gestational and Adolescent Phthalate Exposure with Performance Measures of ADHD Behaviors in Childhood and Adolescence**

Deborah Watkins

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**Abstract:** Attention-Deficit/Hyperactivity Disorder (ADHD) prevalence has been increasing and studies suggest that exposure to endocrine disrupting chemicals such as phthalates may play a role. However, relationships between in utero phthalate exposure and long-term ADHD symptoms are uncertain. We investigated associations between phthalate levels across gestation and ADHD behaviors in childhood (n=217) and adolescence (n=200), as well cross-sectional associations in adolescence. Pregnant women provided urine samples during each trimester for phthalate measurement, and adolescents provided a urine sample at 9-18 years of age. We administered the Conners' Continuous Performance Test (CPT) when children were age 6-11 and 9-18 years. We used multiple linear regression to examine associations between gestational (geometric mean across pregnancy) or adolescent phthalate levels and CPT scores, adjusting for age, schooling (9-18 only), maternal education, and specific gravity. CPT scores for individual domains were weakly correlated between childhood and adolescence (Spearman  $r=0.08-0.38$ ;  $n=195$ ). In utero phthalate levels were not associated with childhood CPT scores. However, in utero MBzP, MCPP, and  $\Sigma$ DBP (MBP, MiBP) were associated with poorer Omissions scores in adolescence (4.2-4.7% increase in scores per interquartile range increase in exposure). In utero  $\Sigma$ DBP was also associated with higher Response Style scores, indicating a preference for accuracy over speed. Concurrent  $\Sigma$ DEHP exposure in adolescence was associated with poorer Hit Reaction Time (HRT) SD and Variability scores, while MCNP was associated with better HRT Block Change scores. Our findings suggest that in utero phthalate exposure may have long-term effects on ADHD behaviors that may not appear until adolescence, a period of substantial neurodevelopment. In addition, phthalate exposure during adolescence may also play a role in the development of ADHD behaviors.

## **P02.2540. Prenatal Exposure to Endocrine Disruptors and Markers of Metabolic Syndrome in Preschool Age: A Birth Cohort Study**

Albino Villarreal

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**Abstract:** Background. The etiology of obesity and the metabolic syndrome (MS) is multifactorial. However, the hypothesis of environmental obesogens suggests that prenatal exposure to chemicals such as phthalates and bisphenol A (BPA) may increase weight gain and risk of developing MS due to possible alterations in fetal metabolic programming. Objective. To evaluate the association between prenatal exposure to phthalates and BPA and the increase in MS markers in preschool children from Mexico. Material and methods. A total of 205 mother-child pairs were included, all participants of a POSGRAD birth cohort study. Information was obtained on sociodemographic characteristics, obstetric and health history and maternal stress during pregnancy and for the evaluation of prenatal exposure to endocrine disruptors, measurements of 9 phthalate metabolites and concentrations of bisphenol A in samples of urine from the mother was realized.. During each postnatal follow-up visit, anthropometric measurements were taken, health information was collected, and at 4 years of age cardiometabolic risk markers were measured in the children. Multiple linear regression models were run adjusting for important confounders. Results 12.7% of the children were overweight (BMI z-score) and 26.5% and 28.4% had high glucose levels and triglycerides respectively. 11.3% had low levels of HDL cholesterol. The concentrations of 7 of the 9 metabolites of phthalates and the concentrations of BPA studied were higher. We found statistically significant associations between some metabolites of phthalates with the levels of total cholesterol, non-HDL cholesterol, LDL cholesterol and the triglycerides / LDL ratio ( $p < 0.05$ ). Conclusions The results of this study strengthen the evidence that exposure to endocrine disruptors during pregnancy increases the risk of metabolic syndrome in preschool age, a situation that may increase the risk of chronic diseases at younger ages of life.

**P02.2550. Prenatal Exposure to Manganese and Maternal Psychosocial Stress-Suppression during Pregnancy Jointly Contributes to Restricted Fetal Growth**

Emilia Pawlowski

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**Abstract:** Introduction Metals exposure and psychosocial stress during pregnancy can contribute to poor birth outcomes. Recent work has shown early life exposure to metals and psychosocial factors jointly contribute to child growth and development. It is unknown whether prenatal metals and psychosocial stress would similarly interact and jointly affect birth outcomes. This study fills this gap and tests whether manganese exposure and maternal stress-suppression during pregnancy would synergistically affect infant birth outcomes. Methods Data were collected from the Albany Infant and Mother Study, an ongoing birth cohort. Manganese exposure was assessed in 150 subjects via toenail sample collected late in pregnancy. Maternal stress-suppression was assessed via a gold-standard questionnaire during pregnancy. Birthweight, head circumference, and infant cephalization indices ((head circumference/birthweight)\*100) were gathered from medical records and examined as outcomes. Multivariable regression models tested main effects and interaction between suppression and manganese in relation to infant birth size outcomes, adjusting for demographic, maternal health, delivery, and infant factors. Results A significant interaction between manganese and stress-suppression was observed in relation to infant cephalization ( $\beta=0.02$ ,  $SE=0.01$ ,  $p<0.05$ ), indicating that infants whose mothers had high levels of manganese and high levels of suppression experienced more asymmetric fetal growth than other groups. Interaction effects were not observed for birthweight or head circumference. Discussion the combined effect of stress-suppression and high manganese exposure during pregnancy contributed to asymmetric intrauterine growth restriction among offspring, indicating potential brain sparing during fetal development. This synergistic effect exceeds that of the main effects of each factor. Interventions designed to promote healthy birth outcomes should consider both metals and psychosocial factors.

## **P02.2560. Effect of Prenatal Exposure to Perfluoroalkyl Substances (PFASs) on Childhood Infectious Diseases up to 7 Years of Age: The Hokkaido Study**

Yu Ait Bamai

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**Abstract:** Background/Aim: Perfluoroalkyl substances (PFASs) are persistent industrial chemicals that have possible effects on the immune system. We have reported the possible impact up to 4 years of age, however, effects on childhood infectious disease at later age is still unclear. We aimed to investigate the association between prenatal PFASs exposure and infectious diseases up to 7 years. Methods: A total of 2689 mother-child pairs, who were enrolled in the Hokkaido Study, were included in this data analysis. Eleven PFASs in 3rd trimester plasma were measured using UPLC-MSMS. Doctor diagnosis of otitis media, chicken pox, pneumonia, and respiratory syncytial virus (RSV), up to 7 years were extracted from the mother-reported questionnaires at 2, 4, 7 years of age. The odds ratio (OR) of log[e] transformed PFASs levels, as well as categorical values were calculated by logistic regression models adjusted for potential confounders such as infant sex, maternal age at delivery, gestational week, parity, household income, any allergies at 7y, and duration nursing. Results: Prevalence of otitis media, chicken pox, pneumonia, and RSV were 55.7%, 61.5%, 30.6%, and 16.8%, respectively. After stratified by siblings with (n=2309) and without (n=379), the increased the adjusted ORs (95% confidential interval) of pneumonia were found with PFOS (1.60, 0.94-2.71 p-value for trend in quartile model=0.039), PFDA (1.66, 1.03-2.66, p trend=0.004), and PFDoDA (1.61, 1.04-2.49, p trend=0.624) and increased the adjusted ORs of RSV were found with PFOA (1.91, 1.07-3.42, p trend=0.005) among children without any siblings. However, any of such associations were not found among children with siblings. Conclusion: Prenatal exposure to PFASs were associated with increased risk of pneumonia and RSV up to 7 years of age only among children without any siblings, however, not among children with siblings.

## **P02.2570. Perinatal Factors and the Development of Childhood Asthma**

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**Abstract:** Perinatal factors are suspected to have a significant impact on the development of asthma; however, sufficiently powered studies have not been performed to investigate this issue. To evaluate whether perinatal factors and other risk factors have an independent or combined effect on the development of asthma. This study involved 3,770 children (mean age 9.1 years, range 5.68-12.16 years; 51.9% boys) who were enrolled in the Elementary School Student Cohort (2009-2014) in Ulsan University Hospital (Ulsan, Korea). Subjects were divided into an asthma group (n = 514) and a non-asthma group (n = 3,256). Multivariate analyses showed that early life (within first week) oxygen therapy (adjusted odds ratio [aOR] 1.864, 95% confidence interval [CI] 1.156-3.004) and breastfeeding (aOR 0.763, 95% CI 0.606-0.960) were 2 significant perinatal factors influencing the development of asthma. Environmental tobacco smoke (aOR 1.634, 95% CI 1.298-2.058) and parental allergic disease (aOR 1.882, 95% CI 1.521-2.328) also were identified as risk factors. Using subgroup analyses, combined effects on asthma development were observed between perinatal factors (early life oxygen therapy and breastfeeding) and other risk factors (vicinity to major roadway [traffic-related air pollution], environmental tobacco smoke, parental allergic disease, and atopy). Early life oxygen therapy and breastfeeding were identified as 2 important perinatal factors influencing the development of asthma. Furthermore, these factors showed combined effects with other risk factors (environmental tobacco smoke, traffic-related air pollution, parental allergic disease, and atopy) on the development of asthma.

## **P02.2580. Prenatal Exposure to Environmental Pollutants and Child Development Trajectories through 7 Years**

Albino Barraza Villarreal

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**Abstract:** Background: Prenatal exposure to environmental pollutants such as mold, lead, pesticides, tobacco, and air pollutants has been suggested to impair cognitive development. Evidence is needed from longitudinal studies to understand their joint impact on child development across time. Objective: To study associations between exposure to indoor environmental pollutants or outdoor air pollution during pregnancy and offspring cognitive development trajectories through 7 years. Methods: We included 718 Mexican mother-child pairs. Prenatal exposure to indoor environmental pollutants (mold, ventilation, pesticides, tobacco smoke, and use of vitrified clay pots) was self-reported by the mothers and integrated into an index, or objectively measured in the case of outdoor air pollutants (nitrogen oxides, benzene, toluene, and xylene). Child global cognitive development was measured at 12, 18, 60, or 84 months. Using Latent Class Growth Analysis, we identified three developmental trajectories (positive=108, average=362, low=248). We used multinomial logistic models to test associations between environmental pollutant score (EPS) or outdoor air pollutants, and cognitive development trajectories. Results: After adjustment for sociodemographic covariates, EPS was associated with the average (OR=1.26 95%CI=1.01, 1.55) and low (OR=1.41 95%CI=1.11, 1.79) trajectories compared to positive; where a unit increase in EPS means an additional prenatal exposure. There was no association between outdoor air pollutants and cognitive development trajectories. Conclusion: Children of women who reported higher exposure to indoor environmental pollutants during pregnancy were more likely to follow worse developmental trajectories through 7 years. These results support the development and testing of interventions to reduce exposure to environmental pollutants during pregnancy and early childhood as a potential strategy to improve long-term cognitive development

## **P02.2590. Housing Characteristics, Asthma Triggers, and Asthma Outcomes: Data from the American Housing Survey**

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Abstract: Some indoor pollutants (e.g. mold, cigarette smoke) are known asthma triggers. Physical housing characteristics may affect exposure to triggers independent of socioeconomic status (SES). This exploratory analysis used 2015 American Housing Survey data on 9,558 households in 25 U.S. metropolitan areas to study relationships among housing characteristics (air conditioning (AC), home age by decade, home type (apartment, mobile home, single-family home)), indoor asthma triggers (mold, musty odors, cigarette smoke, roaches, and rodents), SES, and asthma outcomes among household children. Associations among asthma trigger presence and housing characteristics were analyzed using multivariate logistic regression adjusted for householder race, education, and income. Homes with window AC or no AC had significantly higher odds of having mold, musty odors, rodents, and secondhand smoke infiltration (SHS) than homes with central AC regardless of home type. Apartments had significantly higher odds of having mold, musty odors, SHS, and roaches than single-family homes or mobile homes. Mold, musty odors, SHS, and roaches were significantly associated with older home age. Associations among asthma outcomes and housing characteristics were analyzed using multivariate logistic regression adjusted for householder race, education, income, and presence of triggers. Housing characteristics were not significantly associated with asthma outcomes, with or without triggers in the model. Roaches (odds ratio (OR): 1.33; 95% confidence interval (CI): 1.03-1.72) and mold (OR: 1.65; CI: 1.24-2.18) were significantly associated with asthma prevalence among household children. Musty odors were significantly associated with asthma-related emergency room visits (OR: 1.73; CI: 1.01-2.91) for the youngest child with asthma in each household. This analysis suggests that some housing characteristics are associated with a higher prevalence of asthma triggers and should be considered in future research.

**P02.2600. Differences in Characteristics and Risk Factors between Asthmatic Children with and without Atopic March: A Retrospective Cohort Study**

Ching-Chun Huang

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**Abstract:** Background Although asthma occurrence is often preceded by atopic dermatitis (AD) in the context of atopic march, a significant number of asthmatic children do not co-occur with AD. The aim of the study is to explore the phenotypic differences between asthmatic children with and without atopic march. Methods Eligible participants were selected from the 8-year-old survey of Taiwan Birth Cohort Study, and those ever diagnosed as having asthma were enrolled as study subjects. Demographic characteristics, environmental risk factors, and allergic comorbidities including AD of the subjects were retrieved by trained interviewers. We applied logistic regression models to characterize differences between the two groups. Results A total of 1999 asthmatic children were enrolled in the study, and 455 (22.8%) of them had preceding AD. Determinants favoring AD co-occurrence included maternal history of AD (odds ratio [OR]= 2.91, 95% confidence interval [CI]: 1.82-4.64) and allergic rhinitis (OR= 1.29, 95% CI: 1.00-1.65), paternal AD history (OR= 2.45, 95% CI: 1.51-3.99), maternal postpartum depression (OR= 1.37, 95% CI: 1.07-1.75), urbanization of the residence (OR= 1.56, 95% CI: 1.24-1.95), higher education of mother (OR= 1.48, 95% CI: 1.13-1.93) and father (OR= 1.32, 95% CI: 1.01-1.72), early life food allergy (OR= 3.35, 95% CI: 2.56-4.38), and history of gastritis (OR= 1.46, 95% CI: 1.10-1.93). Nevertheless, asthmatic children with early-onset attention-deficit/hyperactivity disorder were not prone to co-occur with AD (OR= 0.23, 95% CI: 0.08-0.62). Conclusions Early identification of phenotypic determinants between asthmatic children with and without atopic march may help risk stratification and early intervention.

## **P02.2610. Investigating Children's Exposure to Recycled Tire Rubber Used in Playground Surfacing**

Eric Hooker

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Abstract: CPSC is assessing the potential risks to children associated with the use of recycled tire crumb rubber in playground surfaces. Such playground surfaces are a popular option due to their low maintenance, variety of colors and designs, and potential to reduce fall-related injuries. However, parents and playground owners have expressed concerns about the chemical safety of recycled tire materials used in playground surfacing. Children can be exposed to surfacing materials by oral, dermal, and inhalation routes during typical play activities on playgrounds. The scientific literature lacks information to estimate children's exposure to tire constituents from playing on recycled tire rubber playground surfaces. CPSC is using a combination of field observations, focus groups, and a national survey of parents of young children to identify behavioral exposure factors for children on playgrounds. Examples of information sought include frequency and duration of visits to playgrounds, identification and frequency of behaviors and situations that could promote exposure, and parents' awareness of potential hazards and their strategies to reduce exposure. CPSC staff will use the survey results to develop exposure scenarios and models to identify bioavailable substances in recycled tire rubber that may pose a health hazard to children using playgrounds. Subsequent risk assessment strategies will be determined based on review of new data, including the tire crumb rubber characterization and bioavailability studies underway by EPA and CDC/ATSDR, and likely will focus on the substances of highest concern. The poster will review methods and available results of playground exposure data collection and strategies for continued research efforts. This work is that of CPSC staff and has not been reviewed or approved by, and may not necessarily represent the views of, the Commission.

## **P02.2620. Concentrations of Phthalate Metabolites in Children from Poland**

Kinga Polanska

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**Abstract:** Background: Endocrine disrupting chemicals (EDCs) represent a growing public health concern. This is the case of many phthalates, a group of widely used chemicals that affect the hormonal balance in both children and adults. Furthermore, there are critical life stages in which exposures to phthalates may pose an increased risk, such as the developing foetus and the early childhood. The aim of this study was to determine urinary levels of phthalate metabolites in early school children in Poland and compare these results with those observed in other European countries. Methods The exposure to 11 phthalates was determined by measuring 21 phthalate metabolites in urine of 7-year old children from the Polish Mother and Child Cohort Study (REPRO\_PL, n=250, samples collected in 2014-2017), which is the most extensive set of phthalate metabolites ever determined for Poland. Urine sample analyses were performed using on-line high performance liquid chromatography coupled to tandem mass spectrometry (HPLC-MS/MS) using internal isotope-labelled standards. Results: The highest geometric mean concentrations were found in primary monoester metabolites of di-iso-butyl, di-n-butyl and diethyl phthalate, as follows: 75.7 µg/g for MiBP (111.4 µg/g creatinine); 53.9 µg/g for MnBP (79.6 µg/g creatinine) and 42.7 µg/g for MEP (64.4 µg/g creatinine), respectively. Conclusions: These levels are similar to those found in previous studies performed in Poland, but much higher than those from other European populations. The levels of DEHP metabolites in the present study were similar to those observed among children in comparable age from Slovakia but slightly higher than those from Czech Republic and Hungary.

**P02.2630. Impact of Bisphenol A Exposure on Adiposity Trajectory in Early Childhood:  
A Prospective Cohort Study**

Youn-Hee Lim

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**Abstract:** Background: Exposure to bisphenol A (BPA) may impact obesity development, either in the exposed subjects or offspring. Objective: To investigate the association between prenatal and postnatal exposure to BPA and children's body mass index (BMI) as well as its trajectories, in a cohort study. Methods: We recruited pregnant women in their second trimester, between 2008 and 2011; their creatinine-adjusted urinary BPA levels were measured. In 2012-2016, we measured their children's BPA levels, at ages 2, 4, and 6 years, and assessed the BMI values, z-scores, and prevalence of overweight (n = 202). Adiposity trajectories were determined in latent class mixed models. We assessed the association between prenatal mid-term exposure to BPA and postnatal exposure, at each age, and anthropometric measurements, at a single time point, at ages 2, 4, and 6 years. The relationship between prenatal exposure to BPA and adiposity trajectory, over multiple ages, was investigated through linear regression. Results: The association of prenatal and postnatal BPA concentrations with the anthropometric measurements, at a single time point, at 2, 4, and 6 years of age, were not statistically significant after controlling for covariates. However, the adiposity trajectories, over ages 2 to 6 years, were related with prenatal BPA concentrations. A 2-fold increase in prenatal BPA level was significantly associated with increasing adiposity trajectories, in early childhood, by 39.6% (95% confidence intervals: 2.2%, 90.7%). Conclusion: Adiposity trajectory, in early childhood, was affected by prenatal BPA exposure levels. The study provides supporting evidence on the transgenerational effects of BPA on children's growth.

**P02.2640. Environmental Health and Neurodevelopment: Buiding and Using Evidence to Motivate Behavior Change to Improve Children's Health**

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**Abstract:** Objectives: Environmental exposures are known to be significant causal factors contributing to more than 28% of neuro-developmental disorders (e.g. autism, ADHD, intellectual disability) in children. One of the biggest challenges for improving child cognition outcomes is lack of early assessment and monitoring tools. Methods: Many investigators have argued that concern about children's well-being can be leveraged to motivate behavior change in communities. In this direction, we are carrying out a landscape analysis to understand the epidemiological association between environmental exposures such as indoor air pollution and chemical exposure and associated neurodevelopmental outcomes. Exposure assessment is being done using questionnaires. Neuropsychological outcomes shall be assessed using Developmental Scale for Indian Infants tool. EEG, using portable devices, shall help check for attainment of neuro-physiological milestones. All these tools will be administered by local community health workers, after appropriate training. Results: This proposal is a first of its kind of Environmental Neuro-Epidemiology study in India. The questionnaires designed as a part of this study could be used as standard assessment tools. EEG will provide objectivity to the evaluation as well as enable easy-to-scale diagnosis in low resource settings. Implementing the program through primary health care workers shall enable reliable and quick assessment of neurodevelopmental status and thus, help in prevention and management of such avoidable exposures. Conclusions: We believe our activities will trigger the community's desire for collective change, and based on their gained understanding of harmful effects of environmental pollution on their children, lead to transformative change. This prospectively could give rise to the concept of a 'Community Lab' wherein people actively participate in identifying issues that challenge their well being and find solutions to mitigate the impact.

## **P02.2650. Joint and Individual Neurotoxic Effects of Early Life Exposures to a Chemical Mixture: A Multi-Pollutant Approach Combining Ensemble Learning and G-Computation**

Youssef Oulhote

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**Abstract:** Background: The majority of studies do not simultaneously consider multiple co-occurring exposures when assessing potential neurotoxicity. Objectives: To assess associations between developmental exposure to a mixture of pollutants and children's neurodevelopment using a novel approach. Methods: Concentrations of mercury (Hg), polychlorinated biphenyls (PCBs), and perfluoroalkyl substances (PFASs) were measured in maternal and children's blood at 5 years (n=449). At 7 years, children were administered Boston Naming Test (BNT) and the Strengths and Difficulties Questionnaire (SDQ). We used the G-formula combined with the SuperLearner -an ensemble learning technique- to infer effect estimates for the mixture of chemicals and for each pollutant while mutually adjusting for all exposures and potential confounders. We also constructed exposure-response curves and assessed potential interactions. Results: Most chemicals showed a negative relationship with BNT scores. An inter quartile range (IQR) increase in prenatal Hg and perfluorooctanoic acid (PFOA) concentrations was associated with 0.2 standard deviation [SD] (95% Confidence Interval [CI]: -0.3, 0) and 0.1 (95% CI: -0.3, -0.1) lower scores in the BNT, whereas a joint IQR increase in the mixture of chemicals was associated with 0.5 SD (95% CI: -0.7, -0.3) lower scores in the BNT. Additionally, an IQR increase in prenatal perfluorooctane sulfonic acid (PFOS) and PFOA concentrations was associated with 0.15 (95% CI: 0.1, 0.2) and 0.1 SD (95% CI: 0, 0.3) higher (worse) total SDQ scores. A joint IQR increase in chemicals mixture was associated with 0.2 SD (95% CI: -0.1, 0.4) higher SDQ scores. Finally, a joint IQR increase in 5-years mixture of chemicals was associated with 0.2 SD (95% CI: 0, 0.4) higher total SDQ scores. Conclusions: Using a novel multi-pollutant approach, we confirmed previously reported associations between mercury and lower cognitive function. Additional attention should be directed towards emerging PFASs.

**P02.2660. Selenium Protection Against Methylmercury Adverse Neurodevelopmental Effects in Inuit Children from Nunavik, Northern Quebec, Canada**

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Abstract: In Nunavik, prenatal methylmercury (MeHg) exposure has been related to poorer visual and neuropsychological functions and greater risk of attention problems at school age. While some marine foods present high MeHg, others are also exceptionally rich in selenium (Se). Consequently, Inuit present one of the highest blood Se concentrations in the world. High Se intake may contribute mitigating some harmful effects of MeHg, although it never has been reported for prenatal exposure. Selenoneine - a potent antioxidant - may be the key form of Se protecting against MeHg in populations living off a marine diet. The present study aims to determine whether high Se intake can mitigate neurodevelopmental MeHg effects in Inuit children, and whether selenoneine is found in this population. The Nunavik Child Development Study is a prospective mother-child cohort study enrolled at birth with children followed at 11 years old. Total Hg and Se concentrations were assessed in cord and child blood, and selenoneine, in child blood. Neuropsychological and motor functions were evaluated from direct assessment of the child, attention problems by standardized teacher report, and visual function through electrophysiological testing. Control variables were documented through medical records, maternal interviews and blood biomarkers. The modifying effects of Se status on the associations between blood Hg and outcomes were examined using regression models stratified by blood Se. For almost all neurodevelopmental outcomes related to cord MeHg, the harmful effects of prenatal MeHg were significant only in the first cord blood Se tertile group. In child blood, selenoneine represented up to 20% of total Se among those often consuming marine mammals. Marine foods are central to Inuit culture and key source of nutrients for promoting healthy pregnancies and children. Understanding selenoneine health properties will help find solutions to better promote pregnancy wellness with marine foods in the Arctic.

## **P02.2670. Early Life Phthalate Exposure and Cognition at Age 8 Years: Identifying Windows of Heightened Vulnerability**

Medina Jackson-Browne

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**Abstract:** Background: Early-life phthalate exposures may adversely affect children's neurodevelopment by disrupting thyroid function, reducing gonadal hormone levels, or altering concentrations of fatty acids in the brain. We attempted to identify windows of heightened vulnerability to phthalate exposures during fetal period and early childhood. Methods: We used data from 204 mother-child pairs in the HOME Study (Cincinnati, Ohio), a longitudinal pregnancy-birth cohort. We quantified phthalate biomarkers in urine samples collected up to twice at gestational visits and up to 6 times during childhood visits at ages 1-8 years. We assessed children's intelligence (IQ) at age 8 years using the Wechsler Intelligence Scale for Children-IV. We estimated covariate-adjusted associations between log<sub>10</sub>-transformed biomarker concentrations and children's IQ at each visit, and tested for differences in these associations across visits using multiple informants models. Results: The associations between phthalate biomarker concentrations and IQ varied by visit (biomarker\*visit interaction p-values<0.2). Concentrations of monobenzyl phthalate, mono (3-carboxypropyl) phthalate, and monoethyl phthalate at ages 2 and 3 years, and di(2-ethylhexyl) phthalate (ΣDEHP) metabolites at age 3 years were inversely associated with children's full-scale IQ. For example, each 10-fold increase in urine ΣDEHP concentrations at age 3 was associated with a 4.9-point decrease in full-scale IQ (95% confidence interval [CI]: -8.8, -1.1). Concentrations of mono-n-butyl phthalate (MnBP) at age 4 years and mono-isobutyl phthalate at gestation and age 4 years were positively associated with children's IQ. For instance, each 10-fold increase in urine MnBP concentrations at age 4 years was associated with a 5.0-point increase in full-scale IQ (95% CI: 0.8, 9.2). Conclusion: In this cohort, associations of gestational and childhood urinary phthalate biomarker concentrations with IQ scores depended on the timing of exposure.

## **P02.2680. Maternal Plasma Concentrations of Per- and Polyfluoroalkyl Substances and Breastfeeding Duration in the Norwegian Mother and Child Cohort**

Emma Rosen

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**Abstract:** Background: Per- and polyfluoroalkyl substances (PFASs) have been widely produced, many of them persist in the environment, and have been associated with various health effects. Previous studies have identified inverse associations between perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and breastfeeding duration. Methods: We measured the associations between plasma concentrations of 9 different PFASs and cessation of breastfeeding before 3 and 6 complete months using women from the Norwegian Mother and Child Cohort Study (MoBa). The study population includes 1716 primarily nulliparous women from two previous studies of MoBa participants, all enrolled from 2003-2007. The association was measured using Cox proportional hazards models adjusted for confounders and study design. Results: Concentrations of PFASs in this population were lower than concentrations in the previous studies on this topic. We found associations between increasing concentrations of perfluorononanoic acid (PFNA), perfluorodecaconic acid (PFDA), perfluoroundecanoic acid (PFUnDA) and decreased breastfeeding cessation (increased duration). The strongest associations were seen between PFDA and PFUnDA and cessation before 3 months: (hazard ratio = 0.73, 95% confidence interval: 0.62, 0.86). In our population, the other PFASs appeared to be unassociated with breastfeeding cessation or slightly protective. Conclusions: This study is the largest to address this question and is the most well-situated to avoid confounding by previous breastfeeding, given our high proportion of nulliparas. The identification of positive associations between previously unexamined PFASs concentrations and breastfeeding duration is novel and may be explained by differences in transplacental transfer rates.

## **P02.2690. Childhood Lead Exposure and Anthropometry through Adolescence in Girls**

Andrea Deierlein

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**Abstract:** Cross-sectional studies suggest that postnatal blood lead concentrations (PbB) are negatively associated with child growth. Few studies prospectively examined this association in populations with low PbB. We investigated longitudinal associations of childhood PbB and subsequent anthropometric measurements in a multi-ethnic cohort of girls. Data were from The Breast Cancer and Environment Research Program at three US sites: New York City, Cincinnati, and San Francisco Bay. Girls were enrolled at ages 6-8 years in 2004-2007. Girls with PbB collected at  $\leq 10$  years old (mean 7.8 years, standard deviation (SD) 0.82) and  $\geq 3$  follow-up visits were included (n=686). The geometric mean of PbB was 1.03 ug/dL (95% Confidence Interval (CI): 0.99, 1.06) and was dichotomized as "low",  $< 1$  ug/dL (n=344) and "high",  $\geq 1$  ug/dL (n=342). Anthropometric measurements of height, body mass index (BMI), waist circumference (WC), and percent body fat (%BF) were collected at enrollment and follow-up visits through 2015. Linear mixed effects regression, adjusted for race/ethnicity, estimated how PbB related to changes in girls' measurements from ages 7-14 years. At 7 years, mean difference in height was -2.1 cm (95% CI: -3.1, -1.0) for girls with high versus low PbB; differences decreased with age to -1.4 cm (95% CI: -2.5, -0.33) at 14 years. Mean differences for BMI, WC, and BF% at 7 years between girls with high versus low PbB were -0.82 kg/m<sup>2</sup> (95% CI: -1.3, -0.30), -2.3 cm (95% CI: -3.9, -0.65), and -2.2% (95% CI: -3.6, -0.76), respectively. Overall, these differences persisted or decreased with advancing age and at 14 years, differences were -0.69 kg/m<sup>2</sup> (95% CI: -1.5, 0.08), -2.8 cm (95% CI: -4.9, -0.70), and -1.6% (95% CI: -2.9, -0.24) for BMI, WC, and BF%, respectively. These findings suggest that higher levels of PbB during childhood, even though relatively low by screening standards, may be inversely associated with anthropometric measurements in girls throughout early adolescence.

## **P02.2700. Newborn Measures of Persistent Chemicals and Early Childhood Growth**

Edwina Yeung

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**Abstract:** Measurable levels of potentially obesogenic persistent endocrine disruptors remain detectable in pregnant women and newborns. However, few data on newborn exposures prospectively capture childhood growth. Using a novel pooling approach to ensure quantification of environmental chemicals in newborn dried blood spots (DBS), we measured dichlorodiphenyldichloroethylene (DDE), polybrominated diphenyl ether congener 47 (PBDE47), and 10 polychlorinated biphenyl (PCB) congeners for 2,065 (53%) singleton infants participating in Upstate KIDS. Chemicals were measured by gas chromatography-DFS high resolution mass spectrometry. To reach limits of detection, materials from 5 DBS were eluted, pooled and assayed together. We imputed individual level data from measured pools assuming gamma distributions appropriate for the skewed chemical exposures. Children's longitudinal weight and height data were captured on journals designed for parents to complete following pediatric visits through 36 months. Weight gain was evaluated by taking the weight at 4 and 12 months minus birthweight. Rapid gain was then defined as weight gain above 0.5 and 0.67 standard deviation scores from the mean at 4 and 12 months, respectively (cut points associated with fatty liver). Obesity was defined as a 24-36 month BMI greater than 90th percentile for age. Logistic regression was used to estimate odds ratios (OR) and 95% confidence intervals (CI) adjusting for confounders including pre-pregnancy BMI. Higher levels of PCB congeners 18 and 28 were associated with rapid weight gain at 4 months (aOR: 1.15; 1.02-1.29; 1.06: 1.01-1.12 per ng/ml increase in concentrations, respectively), but not at later ages. PCB #153 was associated with risk of rapid weight gain only at 12 months (aOR: 1.09; 1.01-1.19 per ng/ml). None of the associations were robust to correction for multiple comparisons ( $p < 0.005$ ). In conclusion, low levels of persistent chemicals at birth were not associated with early childhood obesity.

## **P02.2710. Relative Uptake of Methylmercury was Higher in the Brain of Fetal and Neonate than Weanling and Adult Rats**

Mineshi Sakamoto

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Abstract: Fetuses and neonates are known to be highly susceptible to methylmercury (MeHg) toxicity. However, little is known about the relative uptake of MeHg from blood to the developing brain compared to adults. We measured time-course changes in MeHg concentrations in the brain of fetal, neonate, weanling, and adult rats following a single MeHg administration. In the experiment at late gestation, MeHg (0.08 mg Hg/kg) was subcutaneously injected to dams on embryonic days 17, 18, 18.5, 19, 19.5, and 20, and the dams and fetuses were dissected on embryonic day 21 (1 day before parturition). Hg concentrations were measured 1, 1.5, 2, 2.5, 3, and 4 days after the injection. Brain Hg levels in fetuses peaked 2 days after the injection and were approximately 1.5 times higher than levels in dams during that period. In the experiment at postnatal periods, the same dose of MeHg was injected subcutaneously to male pups on postnatal day 1 (neonate), 35 (weanling), and 56 (adult). The rats were then sacrificed 1, 2, 3, 4, 5, and 6 days after injection. Brain Hg levels peaked most rapidly in neonates, and levels were approximately 1.5 times higher than levels in weanling or adult rats. Throughout the experiment of the pregnancy and postnatal periods, the Hg level in the blood and Hg brain/blood ratio 24 h after MeHg injection were highest in fetuses, followed by neonates, and decreased with life stage. These results indicate that relative higher brain uptake of MeHg is an important factor for increased vulnerability of fetuses and neonates to MeHg poisoning.

## **P02.2720. Prenatal Exposure to a Mixture of Persistent Organic Pollutants (POPs) and Child Reading Skills at School Age**

Aimin Chen

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**Abstract:** Background: Prenatal exposure to POPs may affect child neurobehavior, however, exposures to mixtures of POPs have rarely been examined. Methods: We estimated associations of prenatal serum concentrations of 17 POPs, including 5 polybrominated diphenyl ethers (PBDEs), 6 polychlorinated biphenyls (PCBs), p,p'-DDE, p,p'-DDT, and 4 polyfluoroalkyl substances (PFAS), in relation to Wide Range Achievement Test-4 reading composite scores at age 8 years in 161 children from a pregnancy/birth cohort (HOME Study, 2003-present) in Cincinnati, OH. We applied six statistical methods: least absolute shrinkage and selection operator (LASSO), elastic net (ENET), Sparse Principal Component Analysis (SPCA), Weighted Quantile Sum (WQS) regression, Bayesian Kernel Machine Regression (BKMR), and Bayesian Additive Regression Trees (BART), to estimate covariate-adjusted associations with individual and multiple POPs. Results: Both LASSO and ENET models showed inverse associations with reading scores for BDE-153 and BDE-28, and positive associations for CB-118, CB-180, PFOA, and PFNA. The SPCA identified inverse associations for BDE-153 and BDE-100 and positive associations for all PFAS, as parts of different principal score mixtures. The WQS regression suggested high weight for BDE-100 and BDE-28 (0.34 and 0.17) in the inverse association model and high weight for PFNA and CB-180 (0.28 and 0.21) in the positive association model. The BKMR model identified BDE-100 and BDE-153 for inverse associations and CB-118, CB-153, CB-180, PFOA, and PFNA for positive associations. The BART method found dose-response functions similar to the BKMR model. No effect modifications between POPs were identified. Conclusions: Despite some inconsistency in congeners, these analyses revealed inverse associations between prenatal PBDE concentrations and children's reading skills. Positive associations between PCB congeners and PFAS and reading skills were also found, but residual confounding cannot be ruled out.

## **P02.2730. Prenatal Lead Exposure and Elevated Blood Pressure in Children**

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**Abstract:** Growing evidence suggests that environmental exposures can influence blood pressure over the course of a lifetime. Exposure to toxic metals has been associated with increased blood pressure in adults, but few studies have examined the impacts of in utero and early life toxic metals exposure on blood pressure in childhood. As subclinical vascular changes are thought to begin early in life, it is possible that in utero toxic metals exposure may play a role in blood pressure homeostasis. As part of the ongoing New Hampshire Birth Cohort Study, we investigated the association between in utero Pb exposure and early childhood measures of blood pressure in 287 children at 5 years of age. Pb was measured in maternal toenail samples collected at 28 weeks gestation and 6 weeks postpartum, which represent exposures ~6 to 9 months prior to collection and therefore reflect the early prenatal and late prenatal exposures, respectively. Blood pressure was assessed as systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP) and pulse rate, for which 3 to 5 measurements of each were recorded and averaged. In preliminary linear regression analyses, adjusted for child age, sex, height, and weight, we observed that a doubling of maternal prenatal toenail Pb was associated with statistically significant increases in child SBP (0.88 mmHg, 95% CI: 0.13, 1.62), MAP (0.57 mmHg, 95% CI: 0.04, 1.10) and PP (0.59 mmHg, 95% CI: 0.01, 1.16). Exploratory analyses stratified by sex suggest that these effects may be stronger among boys, particularly for SBP and MAP. Our preliminary results begin to suggest that in utero Pb exposure may be associated with early life cardiovascular effects in children, which could have consequences for long-term health.

## **P02.2740. Transplacental Transfer Efficiency and Blood Partitioning of Perfluoroalkyl Substances**

Dania Valvi

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**Abstract:** Background: Recent studies have established the ability of perfluoroalkyl substances (PFASs) to pass through the placenta, however data on PFAS transfer efficiency and blood partitioning are limited. Aim: We evaluated transplacental transfer and blood partitioning of 16 PFASs detected in maternal serum, cord serum and cord whole blood, as well as the associations of mother-newborn characteristics with PFAS transfer efficiency and blood partitioning. Methods: We examined 151 mother-child pairs from two Faroese cohorts born in 1999-2001 and 2008-2009. Cord:maternal serum (transplacental transfer ratio [TTR]) and cord serum:whole blood (blood partitioning) ratio were estimated for 9 perfluorocarboxylates, 4 perfluorosulfonates and 3 precursor compounds. Multivariable regression analyses assessed the associations of potential predictors (i.e., cohort, maternal age, parity, gestational diabetes, sex and birthweight) with the ratios. Results: Correlations between maternal and cord serum concentrations were moderate to high for all PFASs ( $\rho$ : 0.41 to 0.95), indicating significant transfer from mother to fetus. Median TTRs ranged from 0.36 (PFDA and PFUnDA) to less than 1 for all PFASs, except FOSA (TTR: 1.21). All PFASs had higher concentrations in serum than whole blood, except FOSA and PFHpA, with partitioning ratios from 0.36 (FOSA) to 2.75 (PFUnDA). PFAS family and carbon chain length were important predictors of transfer and blood partitioning ratios, with U-shaped relationships seen between TTRs and carbon chain length. We also found significantly higher transplacental transfer to newborns of mothers diagnosed for gestational diabetes (adjusted ratio increases between 23% and 44% depending on PFAS). Conclusions: This study suggests that transplacental transfer and blood partitioning depends on PFAS family, carbon chain length and mother-newborn characteristics, such as gestational diabetes. These findings can improve PFAS exposure risk assessment in epidemiologic studies.

**P02.2750. Early Descriptive Results from the Maternal and Developmental Risks from Environmental and Social Stressors (MADRES) Pregnancy Cohort Study**

Theresa Bastain

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Abstract: In recent decades, the prevalence of adult and childhood obesity has dramatically increased in the United States. The burden of this increase in prevalence been shown to disproportionately affect specific racial and ethnic groups. While diet and physical activity are significant determinants of childhood and adult obesity, environmental exposures are increasingly important, yet poorly understood, contributors to obesity. The "Maternal And Developmental Risks from Environmental and Social Stressors (MADRES)" study is a prospective pregnancy cohort of 1000 predominantly lower-income, Hispanic woman-infant dyads in Los Angeles focused on understanding determinants of childhood and pregnancy-related obesity. Enrollment in the MADRES cohort is initiated prior to 30 weeks gestation primarily through partner community health clinics in Los Angeles. Cohort participants are followed through their pregnancies, deliveries, and through their infants' first year of life with a combination of in-person study visits with extensive biospecimen collection and phone questionnaire follow-up. Among the first 208 pregnant women enrolled, 82% self-report Hispanic ethnicity, 40% are predominantly Spanish speaking, 75% report an annual household income of less than \$30,000 and 59% have at most a 12th grade education. Selected pre-pregnancy and pregnancy health characteristics as well as environmental and household characteristics will also be presented. The MADRES cohort study is uniquely positioned to identify key environmental, social and health targets for policy, clinical and programmatic intervention to improve the health of medically-underserved women and children in urban Los Angeles.

## **P02.2760. Prenatal Triclosan Exposure and Thyroid Hormones Measured at Birth**

Kylie Wheelock

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**Abstract:** Triclosan (TCS) is an antibacterial compound introduced in 1972 and used in personal care products including soaps, cosmetics, and toothpastes. It has been shown to disrupt thyroid pathways; thus, exposure among pregnant women is concerning, given the role of thyroid hormones in early brain development. Although TCS was banned by the U.S. Food and Drug Administration in 2016 in soaps, it is still present in toothpastes, deodorants, and shave gels. The literature is inconsistent on the association between TCS exposure and thyroid hormones. We analyzed the association between prenatal TCS exposure and Thyroxine (T4), Free Thyroxine (FT4) and Thyroid Stimulating Hormone (TSH), in cord blood from participants in a prospective cohort study in New York City. Women were enrolled into the Columbia Center for Children's Environmental Health (CCCEH) cohort from 1998-2006. TCS was measured in a spot urine sample collected in the third trimester. Relevant covariates were assessed by questionnaire or medical records. Umbilical cord thyroid hormones were measured for T4, FT4, and TSH. Among N=165 women with both TCS and thyroid hormone measures available, we used linear regression to assess the effects of TCS on thyroid hormones. TCS was detected in 80.5% of CCCEH urine samples with a median concentration of 8.4 ng/mL, after adjusting for urinary dilution. We found significant negative associations between prenatal TCS exposure and T4 ( $\beta = -2.69$ ,  $p=0.01$ ) and TSH ( $\beta = -0.08$ ,  $p=0.03$ ). The associations were strengthened after removing women with planned caesarian sections and restricting to women who went through labor (N=146), T4 ( $\beta = -3.47$ ,  $p=0.003$ ) and TSH ( $\beta = -0.104$ ,  $p=0.014$ ). confirmed, the continued use of TCS should be re-evaluated. We found detectable concentrations of TCS among women who were pregnant before the U.S. FDA ban and significant associations between prenatal TCS and thyroid hormones measured in cord blood. Additional research is needed to confirm the associations.

## **P02.2770. Maternal Race and Fetal Sex Modify the In-Utero Developmental Toxicity of Phthalates**

Michael Bloom

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**Abstract:** Experimental data implicate phthalates as developmental toxicants. Despite ubiquitous human exposure, there are few data assessing the risks of gestational exposure on fetal development. To address this gap, we enrolled 310 black (n=152) and white (n=158) pregnant women, with uncomplicated, singleton live births. Women completed an exposure questionnaire and provided up to 2 urine specimens during pregnancy. We abstracted birth data from the hospital records. We measured 8 urinary phthalate metabolites (ng/mL) and evaluated associations with preterm birth (PTB, <37 weeks' gestation), low birth weight (LBW, <2500 g), birth weight for gestational age (z-score), and small for gestational age (SGA, <10th %tile), adjusted for confounders. We tested for interactions by maternal race and infant sex. We detected an interaction for MEP with PTB (p=.02), with greater risk among blacks (OR=1.43 95%CI=.96, 2.12) compared to whites (OR=.62 95%CI=.34, 1.13). MMP was associated with higher LBW risk (OR=1.90 95%CI=1.11, 3.25), and sex interactions revealed a greater risk of LBW for boys with MBP (p=.002), MiBP (p=.02), MBzP (p=.01), MEP (p=.002), and MMP (p=.09). Lower z-scores were associated with MiBP ( $\beta$ =-.28 95%CI=-.54, -.02) and MMP ( $\beta$ =-.31 95%CI=-.52, -.09) while MEP interacted with race (p=.03), indicating an effect among whites ( $\beta$ =-.14 95%CI=-.28, .001) but not blacks ( $\beta$ =.05 95%CI=-.09, .50). MiBP (OR=2.84 95%CI=1.22, 6.61) and MEOHP (OR=2.79 95%CI=1.05, 7.41) were associated with higher SGA risk. Interactions (p=.09) indicated higher SGA risk for MEHP in whites (OR=3.22 95%CI=.63, 16.39) than in blacks (OR=.71 95%CI=.07, 7.11), and different MBP (p=.04) and MiBP (p=.02) effects, respectively, in boys (OR=2.00 95%CI=.46, 8.70 and OR=2.54 95%CI=1.00, 6.46) and girls (OR=.80 95%CI=.22, 2.97 and OR=3.52 95%CI=1.22, 10.14). Our results suggest that gestational phthalate exposures increase risks for PTB, LBW, and restricted fetal growth, however, the effects vary by race and sex.

## **P02.2780. Phthalate Exposure during Pregnancy and Long-Term Weight Gain in Women**

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**Abstract:** Background: Phthalates are man-made chemicals commonly used in the manufacture of industrial and home products. As they are non-covalently bound to these products, they are easily released into the environment during their manufacture, use and disposal. For this reason, exposure to phthalates is widespread, including among pregnant women. Phthalates are known endocrine disruptors and peroxisome proliferator-activated receptor activators (PPAR $\alpha$ , PPAR $\beta$ , PPAR $\gamma$ ), potentially capable of promoting an obesogenic effect. The aim of the present study was to evaluate the association between phthalate exposure during pregnancy and long-term weight gain in women. Methods: Urinary phthalate determinations, socioeconomic, anthropometric and diet information from 229 women from the Early Life Exposure in Mexico to Environmental Toxicants (ELEMENT) birth cohort were collected during pregnancy. Maternal anthropometric information (body weight, height), was also collected five times within the first year postpartum and twice during follow-up visits 5-10 years later. A path analysis was performed to assess the association pattern between urinary phthalate metabolite levels during pregnancy and change in weight (kg) per year after delivery, including age, education, with/without partner, parity, energy intake and breastfeeding duration. Results: Mono-3-carboxypropyl phthalate (MCP) was associated with a mean increase in weight per year of 0.33 kg (95% CI: 0.09, 0.56); and mono-benzyl phthalate (MBzP) with a mean decrease in weight per year of 0.21 kg (95% CI: -0.38, -0.03). Conclusion: Exposure to certain phthalates during pregnancy might play a role in metabolic changes in women, resulting in long term weight change. This is the first study to evaluate phthalate exposures during pregnancy and long-term weight change in women. More studies on the effects of phthalate exposure during this vulnerable stage in women's health are required.

## **P02.2790. Mixed Metal Exposures and Early Childhood Development**

Antonio Signes-Pastor

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**Abstract:** Background. Children are exposed to multiple chemicals in the environment, including metals such as Pb, As, and Mn. These exposures often occur concomitantly with over- or under-nutrition. We aimed to investigate the associations between mixed environmental exposures and early childhood nutrition status among cohorts of children in Bangladesh and rural New Hampshire. Methods. Child participants from Bangladesh are members of a longitudinal birth cohort established to study the health effects of prenatal and early childhood exposures to metals in the environment; New Hampshire participants are members of the New Hampshire Birth Cohort Study, established to explore the effects of fetal exposure to environmental contaminants. In Bangladesh, umbilical cord blood samples were collected at birth, and blood samples were collected via venipuncture at age 20-40 months. Children with height for age <-2 z-scores below the median of the WHO Child Growth Standards were classified as stunted in all analyses. A multivariable GAM was constructed using tensor product smoothing,  $ti()$ , to test for interactions between metal mixtures. Similar methods are being applied to our New Hampshire Birth Cohort. Results. In Bangladesh, median (IQR) venous blood Pb, Mn and As levels were 5.7 (3.8-8.8), 2.0 (1.5-2.5) and 0.7 (0.3-1.3)  $\mu\text{g/dL}$ , respectively. Results of the GAM highlighted a significant main effect of each individual metal on early childhood stunting (p-values: As = 0.02; Mn = 0.004; Pb = 0.04) and a significant As/Mn interaction (p-value = 0.02). Evidence of a significant As/Mn interaction (p-value = 0.02) was found. Conclusions. Blood Pb and As concentrations were independently associated with increased risk of stunting at 20-40 months; Mn exposure was associated with decreased stunting in rural Bangladesh. Mn exposure decreased the risk associated with As in our Bangladeshi cohort, demonstrating the ability for individual main effects of metals to operate synergistically in a mixture.

## **P02.2800. Distribution and Predictors of Toxic and Essential Metals in the Cord Blood of Chinese Newborns**

Monica Silver

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**Abstract:** Introduction: Prenatal and childhood heavy metal exposures are associated with developmental effects in childhood. In contrast, trace metals are essential for proper growth and development and deficiencies or excesses of these metals can similarly have negative health effects. Here we determined the concentrations of 20 heavy metals and trace elements in umbilical cord blood and identified demographic predictors of exposure. Methods: 20 metals were measured in the umbilical cord blood (plasma-Al, Sb, As, B, Ba, Cd, Co, Cr, Cs, Cu, Hg, Mn, Mo, Ni, Rb, Se, Sr, Ti, Zn; whole-Pb) of 357 infants from Zhejiang Province, China. Relationships between demographic variables and metals were analyzed using generalized linear models and logistic regression. Results: 10 metals (Sb, Co, Cs, Cu, Pb, Mo, Rb, Se, Sr, Ti, Zn) were detected in all samples. Parental occupation and season of birth were the strongest predictors of metals in infant cord blood. Infants whose mothers worked outside the home had 0.3 µg /L higher logHg in their cord blood, compared to those who were housewives ( $\beta$ [95% CI]=0.30[0.06, 0.55],  $p=0.02$ ). Infants whose fathers were managers had 0.6 µg/L higher logBa in their cord blood, compared to those with professional/administrative jobs ( $\beta$ [95% CI]=0.63[0.09, 1.16],  $p=0.02$ ). Infants born in the spring had 0.1-0.2 µg/L higher logAs and logCo in their cord blood ( $\beta$  [95% CI] = 0.22 [0.01, 0.42],  $p=0.04$ ; 0.11 [0.01, 0.22]),  $p=0.04$ ), while infants born in the summer had higher Sb, logB, logHg, and logZn ( $\beta$  [95% CI] = 0.74 [0.24, 1.24],  $p=0.004$ ; 0.11 [0.00, 0.21],  $p=0.04$ ; 0.29 [0.08, 0.49],  $p=0.007$ ; 0.18 [0.06, 0.31],  $p=0.005$ ), compared to those born in fall/winter. Conclusions: Parental occupation and season of birth were the strongest predictors of metals in umbilical cord blood across analyses. Prenatal exposure to toxic heavy metals and early-life trace metal deficiencies have been associated with negative developmental effects and are concerns worldwide.

**P02.2810. Temporal variability of urinary phenol concentrations with use of personal care products in pregnant women**

Rémy Slama

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**Abstract:** Background/Aim: Some phenols are endocrine disruptors commonly used in production of personal care products (PCP). These compounds have a short half-life and past studies have reported detection of some parabens in urine as early as 3 hours after use of PCP. This study aimed at assessing temporal effects of PCP use on urinary concentrations of phenols in an intra-individual study considering shorter and multiple time windows of exposure. Methods: We assayed concentrations of 10 phenols in 114 urine samples from 2 pregnant women collected over a week. Participants also filled detailed diaries with exact time of use of 16 PCP and time for urine collection. We characterized use of PCP as, a) use of a specific PCP (yes/no) b) sum of PCP used in each time window, categorized in 3 percentiles. We used linear mixed models to examine the association between the sum and single PCP use in 6, 12 or 24 hours prior to urine collection and urinary phenol concentrations. Results: Sum of PCP use was associated with increased urinary concentrations of the parabens. The implicated parabens varied by time-window of exposure, in 6 hours, ethyl and butyl paraben, in 12 hours, propyl paraben and in 24 hours, methyl and propyl paraben. Single use of coloured cosmetics, deodorant, shampoo, conditioner and face cream was also associated with increased urinary concentrations of parabens across the 3 time windows. We did not observe clear associations with the other phenols; bisphenol A and S, 2,4 and 2,5 dichlorophenols, benzophenone-3 and triclosan. Conclusion: These results elaborate further that PCP are important sources of exposure to parabens in pregnant women and that effects of PCP use on the 4 paraben urinary concentrations varied by time window of exposure.

## **P02.2820. Pyrethroid Pesticide is Associated with Attention Deficit/Hyperactivity Disorder Symptom in 4-Year Old Children**

Wooseok Lee

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**Abstract:** Background: Using pyrethroid insecticides has increased rapidly over the past decade. Pyrethroid pesticides are known to be able to cause abnormalities in the dopamine system and affect an Attention Deficit/Hyperactivity Disorder (ADHD) phenotype in animal experiments. However, studies about their potential health effects, especially on children, are limited. In this study, we assessed the association between use of pyrethroid insecticides and ADHD symptom in 4-year old children. Methods: We conducted an analysis of 385 participants in Environment and Development of Children (EDC) Study who were 4 years old from 2014 to 2015. Creatinine adjusted 3-PBA concentration was measured in children's urine at 4 years of age. We assessed the association between urinary 3-PBA concentration and using pyrethroid insecticides from living environment questionnaire and also assessed the association between urinary 3-PBA concentration and ADHD symptom through generalized estimating equations (GEE). Results: The mean 3-PBA concentration in children's urine at 4 years of age was 2.267  $\mu\text{g/g}$  creatinine. Natural log transformed 3-PBA concentration was significantly associated with children's ADHD symptom ( $\beta = 0.057$ ,  $P = 0.003$ ). When stratified by gender, it was significant in boys but not in girls. Higher urinary 3-PBA concentration was significantly associated with using pyrethroid pesticide ( $\beta = 0.339$ ,  $P = 0.009$ ). Conclusion: Our study results indicate that urinary 3-PBA concentration in 4-year old children increases the risk of developing ADHD. As the use of pyrethroid pesticides is increasing, more attention should be paid to their health effects.

## **P02.2830. Impacts of Prenatal Polycyclic Aromatic Hydrocarbons Exposure on Cancer-Related Gene Expression of Fetus**

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**Abstract:** Objective To explore the effects of prenatal polycyclic aromatic hydrocarbons (PAHs) exposure on genome-wide mRNA expression, and to screen the major PAHs that make the largest contribution to variance of gene expression of fetus. Methods Seven carcinogenic PAHs in cord serum were detected using high-performance liquid chromatography (HPLC)/fluorescence. Affymetrix microarray was used to test the variance of genome-wide mRNA expression of cord blood. The relationships of prenatal PAHs exposure and the expression level of cancer-related genes, and the contribution of prenatal PAHs exposure to variance of cancer-related genes expression were analyzed. Results Seven carcinogenic PAHs could be detected in about more than 70% of cord serum samples. 1847 genes were declared to be significantly differentially expressed among 5 groups with different PAHs levels and the tumor-related pathways predominated in the pathway-network. Significant correlations between cord serum PAHs levels and mRNA expression levels of genes of SNRPN, RPL27A, BMP1, NUDT2, E2F1 and RAD54B were discovered ( $p < 0.05$ ). BbF had the most association with gene expression, and then were BkF and BaP. Conclusion Six cancer related genes can be identified as candidate target genes of prenatal PAHs exposure, and BbF, BkF and BaP were in the key position on affecting expression of the six cancer related genes.

## **P02.2840. Prenatal Lead Exposure and Cord Blood Methylation: An Epigenome-Wide Association Study in the Mexican Progress Cohort**

Jonathan Heiss

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**Abstract:** Background: Lead is a paradigm toxicant in children yet little is known about its epigenetic effects. Previous studies reported associations between lead exposure during pregnancy and cord blood methylation levels. It is however unclear during which developmental stage lead exposure is most harmful. The aim of this study was to investigate the possible impact and window of susceptibility of lead on cord blood DNA methylation. Methods: Cord blood methylation levels were assayed in 448 children from a Mexican birth cohort using the Infinium MethylationEPIC microarray. Lead concentrations were measured in umbilical cord blood as well as in blood samples from the mothers collected at 2nd and 3rd trimester and delivery using inductively coupled plasma-mass spectrometry and maternal bone lead levels in tibia and rotula using X-ray fluorescence. Comprehensive quality control and preprocessing of microarray data was followed by an unbiased restriction to 204,567 CpG sites with substantial variance. Robust methods were used to regress the methylation levels at every CpG site on each exposure additionally adjusting for leukocyte composition, batch variables, gestational age and weight z-scores, maternal age and education, parity and mode of delivery. Results: Testing the association between the 6 lead exposures and 204,567 CpG sites, no significant hits were found at a 5% false discovery rate. Conclusions: While sample size was larger (1.4× at 3rd trimester) and average lead levels and standard deviation thereof were higher (3.2× and 4.3×, respectively) than in a similar epigenome-wide association study, the number of tested association was 3.1× higher as well. The study had an 80% power to detect correlations >0.21. Nonetheless, this null result might be due to the lack of statistical power. Future work will consider more powerful statistical approaches that jointly combine proximal methylation sites that may be co-regulated.

## **P02.2850. Perfluoroalkyl Substances and Thyroid Function in Pregnant Women and their Offspring**

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**Abstract:** Background: Normal thyroid function during pregnancy is critical for fetal development. Experimental studies suggest that certain perfluoroalkyl substances (PFAS) may disrupt thyroid function but findings from observational studies have been inconsistent. Aim: To examine the association between maternal PFAS concentration in pregnancy with 1) maternal thyroid function in pregnancy and 2) offspring thyroid function 20 years later. Methods: In a cohort of Danish pregnant women who gave birth in 1988-89 concentrations of PFAS, thyroid stimulating hormone (TSH) and free thyroxine (FT4) were quantified in 876 women using samples from week 30 of gestation. TSH and FT4 concentrations were also quantified in 411 offspring 20 years later. Results: The median concentrations of PFHxS, PFOS, PFOA, PFNA and PFDA were 0.35 ng/mL, 21.5 ng/mL, 3.7 ng/mL, 0.34 ng/mL and 0.05 ng/mL, respectively. In pregnancy concentrations of PFNA were associated with around 14% higher maternal TSH concentrations (95% CI: 10%, 30%) when comparing the highest to lowest quartile of exposure (p for trend=0.04). Non-significant but positive associations were observed for the other compounds and no associations were observed with maternal FT4. Prospectively maternal concentrations of PFOA were associated with around 24% higher (95%CI: 8%, 43%) TSH concentrations in the offspring at 20 years when comparing the highest to lowest quartile of maternal PFOA exposure (p for trend = 0.01). A modest non-significant association was observed for PFOS (p for trend = 0.13). No associations were observed for the other compounds and no associations were observed with offspring FT4 concentrations. Conclusion: Except for PFNA no clear link was observed between circulating PFAS concentrations and thyroid function in pregnancy. Prospectively, there were some indications that maternal PFOA concentrations may be associated with higher offspring TSH concentrations at 20 years but replication is needed to exclude chance findings.

## **P02.2860. Self-Reported Oil Spill Exposure and Birth Outcomes: The Growth Study**

Emily Harville

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**Abstract:** Background: The chemical, economic, and social effects of a major oil spill might affect pregnancy health. Methods: Between 2012 and 2016, 1444 women reported their involvement with the 2010 Gulf of Mexico oil spill, as well as at least one livebirth. Indicators of oil spill exposure included financial consequences, direct contact with oil, traumatic experiences, loss of use of the coast, and involvement in litigation. Birth outcomes studied were low birthweight (LBW; birthweight <2500 g) and preterm birth (PTB; >3 weeks early), either obtained as self-reported information or abstracted from medical records if the woman was still pregnant at the time of the interview. All pregnancies prior to the oil spill were considered unexposed; those after the oil spill were considered exposed or unexposed depending on interview responses. Generalized estimating equations with a logit link and adjustment for confounders were used to assess the relationship between oil spill exposure and these outcomes. Results: 370 (13.2%) of pregnancies were reported as ending in LBW, while 273 (9.7%) as ending in PTB. Births after the oil spill were not more likely to end in either outcome (adjusted odd ratio, 0.96, 95% CI 0.73-1.24 and 0.98, 0.72-1.33). Financial consequences, trauma, use of coast, and litigation were not associated with worse birth outcomes (ORs between 0.8 and 1.2). Risk of preterm birth was raised in the group with most contact with oil (aOR 2.30, 1.16-4.59), although sensitivity analyses did not indicate this result was robust to other assumptions. Conclusions: Self-reported exposure to most aspects of the Gulf oil spill were not associated with adverse birth outcomes. The raised risk for PTB among those in contact with oil warrants examination in studies with more detailed assessment of exposure.

## **P02.2870. Associations between Organophosphate Flame Retardant Exposure during Pregnancy and Reproductive and Thyroid Hormone Levels: A Preliminary Analysis**

Deborah Watkins

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**Abstract:** The use of organophosphate flame retardants (PFRs) in consumer products has increased in recent years due to the phase out of polybrominated diphenyl ethers. As a result, exposure to PFRs is widespread, with uncertain impacts on health. A previous study of pregnant women undergoing in vitro fertilization found that higher urinary PFR metabolites were associated with decreased treatment success, while another reported associations between a PFR and increased thyroid hormone in women. Therefore, we aimed to investigate relationships between PFR exposure and serum hormone levels among a subset of pregnant women enrolled in the Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) birth cohort (n=148). We measured 7 PFR metabolites (bis-2chloroethyl phosphate (BCeP), bis-(1-chloro-2propyl) phosphate (BCPP), bis(1,3-dichloro- 2-propyl) phosphate (BDCPP), di-n- butyl phosphate (DNBP), di-benzyl phosphate (DBzP), di-cresyl phosphate (DCP) and diphenyl phosphate (DPHP)) in urine samples collected at 16-20 and 24-28 weeks gestation. Testosterone (T), estradiol (E2), estriol (E3), progesterone, corticotropin-releasing hormone (CRH), sex hormone binding globulin (SHBG), thyroid stimulating hormone (TSH), T4, T3, and free T4 (fT4) were measured in serum samples collected at the same time points. We used linear mixed models to assess relationships between PFRs and hormone levels across pregnancy, adjusting for age, pre-pregnancy BMI, and specific gravity. DNBP, DBzP, and DCP were detected in <50% of samples. BCeP was associated with higher SHBG, while BDCPP was associated with higher T, E2, and fT4. BCPP was associated with lower E2, and DPHP was associated with lower T4. These preliminary findings suggest that PFRs may disrupt hormone levels during pregnancy. Further research into endocrine disruption as a mechanism by which PFR exposure during pregnancy may affect pregnancy and birth outcomes, as well as fetal and child development, is necessary.

## **P02.2880. Dental Amalgams and Risk of Gestational Hypertension in the MIREC Study**

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**Abstract:** Background: The potential association between the presence or replacement of dental amalgams and gestational hypertension with or without preeclampsia (GH) is unclear. Objective: To assess the association between the presence or replacement of dental amalgams and the risk of GH in a prospective cohort study. Methods: We assessed dental amalgam status (presence or replacement), blood mercury concentrations, and measured blood pressure in 1909 pregnant women recruited in 10 Canadian cities between 2008 and 2011 as part of the Maternal-Infant Research on Environmental Chemicals (MIREC) Study. Blood pressure was assessed in each trimester of pregnancy and mercury concentrations in 1st and 3rd trimesters. Logistic regression analysis was performed to estimate the adjusted odds ratio (aOR) and 95% confidence intervals (CI) for the association between dental amalgam status and GH. Concurrent measures with GH were assessed through logistic generalized estimating equations. Results: Dental amalgam status was weakly and statistically correlated with blood mercury concentrations but there was no evidence of an association with GH in women having 1-4 (aOR = 1.31; 95% CI: 0.92, 1.85) or  $\geq 5$  dental amalgams (aOR = 1.32; 95% CI: 0.86, 2.04), compared to women without amalgam reported at first trimester. Dental amalgam replacement reported in the first or third trimester was similarly not associated with GH (aOR = 0.75; 95% CI: 0.40, 1.42 and aOR = 0.73; 95% CI: 0.39, 1.34, respectively). Conclusion: We found weak correlations between dental amalgams and blood mercury among pregnant women. However, the presence of dental amalgams or their replacement was not associated with a statistically significant increase in GH risk. Further studies are required to confirm these results.

## **P02.2890. Trace Elements in Human Milk from Italian Lactating Women: Comparison with Infant Formulas**

Elena Righi

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**Abstract:** Background: Human milk is the best source of nutrition for the newborns, and exclusive breastfeeding is recommended by WHO up to 6 months of age. It contains all the nutrients and essential trace elements necessary to ensure correct functioning of the organism. Infant formulas, the most common substitutes for human milk, usually contain nutrient levels modeled to have a composition similar to human milk. However, few recent data on nutrient levels in breast milk and infant formula are available from women living in Italy. The aim of this study was to determine the levels of five essential (Fe, Zn, Cu, Mn, Se) and four non-essential/toxic elements (Ni, Cr, Cd, Pb) in infant formulas and breast milk of women living in Modena, Italy and to compare them with recommended values. Methods: 130 samples of human milk (mature milk: 30-40 days postpartum) and a representative sample of infant formulas (0-6 months) sold in Italy were analyzed by ICP-MS in triplicate after microwave digestion. Results: Breast milk showed adequate levels of essential trace elements, despite the inter-individual variability observed, which was not influenced by women's characteristics and dietary habits. Non-essential/toxic elements content was well below the maximum tolerable limits set by the European Food Safety Authority (EFSA). In infant formulas as well, essential element levels were within the European recommended values, however, Fe and Mn levels, were significantly higher than in breast milk. Conclusions: The levels of essential micronutrients in lactating women living in Modena are suitable for the proper development of infants and no risk for excessive toxic elements intake was detected. Infant formulas show high fortification with Fe and Mn. Considering the growing evidence of cognitive development effects due to an excessive Mn intake, a deeper discussion on infants' Mn requirement is needed. According to our findings, breastfeeding should be still encouraged and recommended.

## P02. Adult Health Effects of Environmental Exposures 2

### **P02.2910. Association between Per- and Polyfluoroalkyl Substances (PFASs) and Thyroid Hormones in a High- Exposed Swedish Population**

Ying Li

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**Abstract:** Per- and polyfluorinated compounds (PFASs) have endocrine disrupting properties. Alterations in thyroid hormone homeostasis have also been observed in animal experimental studies, and in some cross-sectional studies in the general population, often with ambiguous results, and data for other PFASs than PFOA and PFOS is scarce. In December 2013 high levels of PFASs were detected in one out of two waterworks in Ronneby, a municipality with 28000 inhabitants. This waterworks supplied 1/3 of the households. The source of PFASs was groundwater contamination from firefighting foam. This "natural experiment" enables epidemiological investigations over a wide exposure span, dominated by exposure to PFOS and PFHxS. Between 2014-15, 3285 individuals with a wide age span from the municipality and a nearby reference community participated in open blood samplings. We investigated thyroid hormone levels in this combined group, having serum levels for PFOS median 160 (10, 90 percentiles 11, 560) ng/ml, PFHxS 140 (6, 540) and PFOA 9 (2, 29) ng/ml. The associations between PFASs and thyroid hormone were assessed using linear regression in stratified groups of gender and age (2-11, 12-19, 20-49, 50+). It was found that in girls aged 2-11, there were significant positive associations between PFASs and free T3 (fT3). A doubling of PFASs level was associated with 1-2% increase. In other age groups of female, there were no significant associations. In males, no significant associations were found between PFASs and fT3 in any age groups. For fT4, a weak positive association ( $p < 0.1$ ) were observed in females aged 12-19. In boys aged 2-11, there were positive association. Statistically significant associations between PFASs and TSH were not observed in any age groups neither for females or males. In general, females were more sensitive to PFASs with respected to thyroid hormones. Prepubertal girls in this highly exposed group showed a small increase of free T3 with increasing PFAS exposure.

## **P02.2920. Association of Perfluoroalkyl Substances with Hyperuricemia and Gout**

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**Abstract:** Previous population cross-sectional studies have reported a positive association of polyfluoroalkyl substances (PFASs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), with hyperuricemia and chronic kidney diseases (CKD) defined as estimate glomerular filtration rate (eGFR) <60 mL/minute/1.73 m<sup>2</sup>. We investigated whether there is an association between exposure to PFAS, and serum uric acid and gout in the adult population of the (NHANES) 2009-2012 (n=3248). PFAS includes PFOA, PFOS perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS). Multivariate logistic regression were performed to analyze the association of PFAS with hyperuricemia and gout. Serum PFOA, PFNA, PFOS and PFHxA were analyzed as quartiles. Multivariate linear regression were performed to analyze the association of PFAS with uric acid and eGFR. Analyses were also restricted to individuals with normal eGFR. The weighted prevalence of hyperuricemia was 17.7 % (95% CI: 15.8% - 19.73%), and of self-reported gout was 3.2 % (95% CI: 2.5% - 4.1%). After adjustment for potential confounders, all four PFAS investigated were associate with increased serum uric acid and decreased eGRF. There were statistically significant associations between the highest quartile of PFOA, PFNA and PFHxS, but not PFOS, and hyperuricemia. These association were confirmed for PFOA and PFNA, when the analyses were restricted to participants with normal eGFR. The adjusted odd ratio for gout among participants in the 4th PFOA quartile was 2.80 (95% CI: 1.16, 6.74) compared the 1st PFOA quartile. The positive association was also found when the analyses excludes individuals with CKD. In this population cross-sectional analysis, we found an association between PFOA with self-reported gout. We also confirmed previous reports of an association of PFAS with hyperuricemia and decreased eGFR. Longitudinal studies examining the relationship of PFAS renal function are needed.

**P02.2940. A Lifestyle Intervention of Exercise and Diet Attenuates Obesogenic Associations of Per- and Polyfluoroalkyl Substances: Results from the Diabetes Prevention Program**

Andres Cardenas

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**Abstract:** Background: Per- and polyfluoroalkyl substances (PFASs) are ubiquitous synthetic chemicals, widely detected across populations and suspected endocrine disruptors. We sought to determine the extent to which PFASs are prospectively associated with weight and body size and evaluate if a lifestyle intervention modifies this association. Methods: We utilized data from the Diabetes Prevention Program trial (DPP; 1996-2001) and Outcomes Study (DPPOS; 2002-2014) of participants initially randomized to a lifestyle intervention or placebo and followed for up to 15 years. The lifestyle intervention consisted of training in diet, physical activity, and behavior modification with the major goals of achieving 7% weight loss and 150 min/week physical activity. Participants randomized to placebo received standard information about diet and exercise. We quantified six plasma PFASs at baseline and two years post randomization, and calculated total PFAS by summing the means of the two measurements. Results: In this sample, 481 participants were initially randomized to a lifestyle intervention and 476 to placebo. PFAS concentrations were not different by treatment and similar to concentrations reported for the U.S. population in 1999-2000. Each doubling in total PFAS concentration was associated with 1.03-cm increase in hip girth during DPP (95% CI: 0.18, 1.88; P=0.017), an increase of 1.80-kg in weight from baseline to 9 years post-randomization (95% CI: 0.43, 3.17; P=0.01) and greater waist circumference trajectories (P=0.001) for the placebo group. No adverse associations were observed for the lifestyle intervention group. Conclusions: Among adults at high risk for diabetes we observed that higher plasma PFAS concentration was associated with increases in weight, waist circumference and hip girth, but a lifestyle intervention attenuated these associations. Our results suggest that diet and exercise may mitigate obesogenic effects of environmental chemicals.

**P02.2960. Aluminum (Al) Level in Blood and the Risk of Amnestic Mild Cognitive Impairment (AMCI) and Alzheimer's Disease (AD): A Case-Control Study**

Jee-Eun Choi

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**Abstract:** Background: Aluminum(Al) is known as a potential environmental neurotoxin substance. Epidemiological studies have found the evidence of an association between aluminum exposure neurodegenerative disorders. Most of the studies tend to emphasize the association between aluminum and Alzheimer's disease(AD), while few studies have been suggesting Serum aluminum could effect on cognitive disorders including mild cognitive impairment. Thus, this study focused on finding out the association between serum aluminum level and amnestic mild cognitive impairment (aMCI) or Alzheimer's disease (AD) Method: A matched case-control study was conducted. 136 aMIC patients and 191 Alzheimer's disease patients were recruited from a university-based hospital from 2014 to 2017. Participants (N=1957) were older than 60 years and were from community based cohorts in Seoul, Incheon, Ganghwa and Wonju, South Korea. Four healthy controls for each aMCI (N=123) patients and AD patients (n=136) were randomly selected using age and sex matching method. Serum aluminum level was analyzed from the collected blood samples. Conditional logistic regression was used, adjusting for age, education level, BMI, total cholesterol, triglyceride, high-density lipoprotein cholesterol, smoking and drinking. Results : The geometric means of aluminum level in the blood was 11.16µg/L (95%CI 10.04, 12.39) in AD patients and was 8.57µg/L (95%CI 8.14, 9.03) in control group. The geometric means of aluminum level was 11.09µg/L (95%CI 10.20, 12.06) in aMIC group and 8.35µg/L (95%CI 7.91, 8.81) in its control group. The odds ratios was 2.77 (1.70-4.58) for aMCI and 2.66(1.64-4.31) for AD. Conclusions: Aluminum level in blood was positively associated with the risk of aMIC and AD.

## **P02.2970. The Involvement of Gene Expression of Heat Shock Proteins in Cd Renal Toxicity**

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**Abstract:** Cadmium (Cd) is an environmental contaminant that induces toxic effects in various tissues including the kidney. The kidney is the target tissue in chronic dietary Cd exposure. Proximal tubular cell damage is characterized as Cd-induced renal damage. In our previous study, DNA microarray result showed that Cd treatment not only increased the expressions of 30 genes more than 2-fold, but also decreased those of 21 genes less than a half in HK-2 human proximal tubular cells. Among the genes whose expressions were increased by Cd, several heat shock protein genes were included. Heat shock proteins are known to play important roles in protective pathway against various stresses in cells. In this study, we examined the effect of heat shock protein genes on the viability of HK-2 cells treated with Cd. HK-2 cells were treated with 5 and 10  $\mu\text{M}$  Cd for 6 h. Although the cell viability was decreased by Cd treatment, HSPA1A, HSPA1B, HSPH1, HSPA8 gene expressions were increased by Cd treatment. Next, it was examined whether knockdown of heat shock protein genes affect the HK-2 cell viability upon Cd treatment. Knockdown of HSPH1 by siRNA treatment decreased the viability of 5  $\mu\text{M}$  Cd treated HK-2 cells compared with control siRNA treatment group. Knockdown of HSPA8 by siRNA treatment decreased the viability of non-treated and 5  $\mu\text{M}$  Cd treated HK-2 cells compared with control siRNA treatment group. These results suggest that several heat shock proteins may be involved in the protective effect against Cd toxicity in HK-2 cells.

## **P02.2980. Atmospheric Metals and Cancer Incidence in the GAZEL Cohort (1996-2014)**

Emeline Lequy-Flahault

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**Abstract:** Background/Aim Metals such as cadmium are acknowledged or suspected carcinogenics. Yet the association between atmospheric metals and cancer incidence has rarely been investigated, as exposure is difficult to assess. We aim to analyze the relationships between atmospheric metals and the incidence of cancer in the French general population-based cohort Gazel. Methods We used four moss biomonitoring surveys, mainly conducted in the French countryside between 1996-2011, to assess the exposure to 13 atmospheric metals including cadmium, mercury and lead, as the mean rank of the exposure at home address to each metal over the follow-up of 11,212 participants living in low and moderate population density areas with incidence of all, bladder, breast, colorectal and kidney cancer between 2001-2014. We used Cox models to derive hazard ratios for a 2000-rank increase of exposure to each atmospheric metal, adjusted for gender, socioeconomic status, alcohol and tobacco use, family status, and with age as the underlying time scale. Results We found significant associations between incidence of all cancers and As, Cd, Cu, Hg, and Zn with HR ranging from 1.05 (CI 1.01-1.08) and 1.07 (1.04-1.11); between incidence of lung cancer and Al, Cd, Cr, Cu, Fe, Hg, Ni, and Zn with HR ranging from 1.14 (1.00-1.09) and 1.25 (1.10-1.44); between incidence of bladder cancer and Al and Fe with HR of 1.14 (1.00-1.30) and 1.15 (1.00-1.31), respectively; between incidence of kidney cancer and Cd, Hg, and Zn with HR ranging from 1.20 (1.00-1.43) and 1.21 (1.01-1.44). Incident colorectal cancer was associated with exposure to Na with an HR of 1.12 (1.00-1.25). No significant association was found between incident breast cancer and atmospheric metals. Conclusions Atmospheric metals, mainly those from anthropogenic sources, are associated with incidence of all-cause, lung, and kidney cancer for participants of the Gazel cohort living in low to moderate population density areas.

## **P02.2990. Rice Consumption and Incidence of Bladder Cancer in a United States Population**

Antonio Signes-Pastor

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**Abstract:** **ABSTRACT** Background: Intake of rice increases exposure to inorganic arsenic, a known bladder carcinogen, as well as arsenic species with lesser known toxicity. Methods: To investigate whether rice intake contributes to risk of bladder cancer, rice consumption was assessed using a food frequency questionnaire administered as part of a U.S. population-based case-control study of 316 bladder cancer cases and 230 controls. Total arsenic concentration in household tap water samples was measured using inductively coupled plasma mass spectrometry (ICP-MS). Odds ratios (OR) for bladder cancer associated with the frequency of rice consumption, and white and brown rice separately, and stratified by household water arsenic concentration, were estimated using logistic regression adjusted for potential confounders (i.e., age, gender, caloric consumption, cigarette smoking status, and education). Results: No overall association was observed with any versus no rice consumption (OR = 0.8, 95% confidence interval (CI): 0.5 - 1.3), nor was any association observed among those with household water < 1 µg/L arsenic. Among those with ≥ 1 µg/L water arsenic, odds ratio increased with frequency of rice consumption (OR = 0.8, 95% CI: 0.2 - 2.9 for 1-20 g/day, OR = 3.2, 95% CI: 0.8 - 13.2 for > 50 g/day, p for trend = 0.05). Associations were particularly strong among those who frequently ate brown rice. Conclusion: Our findings suggest that rice consumption may be related to the occurrence of bladder cancer among those with higher household water arsenic concentrations.

## **P02.3000. Exposures to Paraben and Triclosan and Allergic Diseases in Tokyo: A Cross-Sectional Study**

Yukihiro Ohya

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**Abstract:** Rationale: Paraben (Pb) and Triclosan (TCS) have been contained in many commodities such as soap, toothpaste, ointment, cosmetics and etc. Exposure to Pb or TCS was implicated to be a risk factor of allergic diseases. However, an epidemiological study to explore the association between exposure to Pb or TCS and allergic diseases in Japan has remained to be seen. Methods: Cross-sectional study to detect commodities containing Pb and TSC was carried out in the National Center for Child Health and Development between 2016 and 2017. We examined participants' urinary concentrations of Pb and TCS and assessed their allergic diseases by using a questionnaire (International Study of Asthma and Allergies in Childhood). Result: In statistical analysis, 223 participants (146 children and 77 adults) were included. The users of hand wash and body wash containing TCS were 5.7%. The user of commodities containing Pb were 95.6%. Children showed higher urinary Pb concentration than adults ( $p < 0.0001$ ). Participants with Atopic Dermatitis (AD) demonstrated higher urinary Pb concentration than those without AD ( $p < 0.0001$ ). The level of urinary TCS concentration was under the limit of detection in all participants. Conclusion: To the best of our knowledge, this is the first report to examine current Pb and TCS exposures among children in Japan. In our study populations, users of commodities containing TCS was very few, while exposure to Pb containing commodities was very common. Pb exposure was higher in children and AD.

## **P02.3010. Risks of Three Substance Uses, Facial Flushing, Helicobacter Pylori Infection and Upper Digestive Diseases**

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**Abstract:** Background: This study examines the effects of common environmental hazards such as tobacco, alcohol (facial flushing or not), areca nut, and Helicobacter pylori infection on different upper digestive diseases. Methods: This is a multi-hospital-based endoscopy-survey cross-sectional study. Study subjects were those who aged  $\geq 20$  years, received upper endoscopies, agreed to participate, and did not have diagnosed and treated for gastric-esophagus cancers or upper digestive tract operations in outpatient clinics at four hospitals from southwestern coast of Taiwan in a period of April 2008 and December 2013. Then, they were collected the necessary personal information and were checked the status of Helicobacter pylori (HP) infection. Adjusted odds ratio (aOR) and 95% confidence interval (CI) were presented. Results: In total, 8135 subjects were analyzed. Higher cumulative amounts of alcohol consumption were at higher risk of Barrett's esophagus and esophageal squamous cell carcinoma (ESCC), higher cumulative amounts of tobacco consumption were at higher risk of peptic ulcer, and higher cumulative amounts of areca nut consumption were at higher risk of duodenitis. For facial flushing, it was the significant risk for reflux esophagitis and Barret's esophagus (aOR = 1.18 and 1.32, 95%CI = 1.07-1.31 and 1.06-1.65, respectively), but not the risk of ESCC. In addition, HP infection was consistently and significantly risk factors for gastrointestinal diseases, including peptic ulcer, gastric adenocarcinoma, and duodenitis. Conclusion: Besides the risk of of alcohol, tobacco, and areca nut for Barrett's esophagus and ESCC, peptic ulcer, and duodenitis, respectively, presence of facial flushing was the significant risk for reflux esophagitis and Barret's esophagus and HP infection was significantly risk factors for gastrointestinal diseases, including peptic ulcer, gastric adenocarcinoma, and duodenitis.

**P02.3020. Pesticide Use and Lung Cancer Risk in the Korea National Cancer Center Community-Based Cohort Study: A Propensity Score Matching Analysis**

Byungmi Kim

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**Abstract:** Background: Pesticide use is associated with lung cancer, but the situation regarding lung cancer has not been clearly defined. We proposed a propensity score matching (PSM) analysis to evaluate relationship between pesticides use and risk of lung cancer in the Korea National Cancer Center community-based Cohort Study (KNCCCS). Methods: We evaluated use of pesticide and lung cancer cases in the KNCCCS, a prospective cohort study comprising 16,304 study participants from South Korea. Information about pesticide use and other factors was collected at enrollment (1993-2010). We compared four propensity-score-based approaches to confounding adjustment: matching, stratification, inverse probability treatment weighting (IPTW), and use of PS as a covariate. The differences in the baseline characteristics according to pesticide use were summarized using absolute standardized differences. Results: The hazard ratios between pesticide use and lung cancer varied from 3.04 (multiple model without PSM) to 5.40 (Stratification by 5 strata on the PSM). With all PSM methods, regression model adjusted as a continuous term with propensity score yielded estimated hazard ratios ranging from a low of 3.05 (95% CI: 1.27, 7.32) when IPTW was included to a high of 4.53 (95% CI: 2.61, 7.89). Results varied slightly by method, but direction and statistical significance remained the same. Conclusions: Our findings has strengthen the provide evidence for an association between pesticide use and lung cancer risk. Acknowledgements : This study has been financially supported by the National Cancer Center of Korea (grant numbers: NCC-1610650-1).

## **P02.3030. Hypertension, Cytokines, and Dioxin-Like Compounds in the Anniston Community Health Survey II**

Marian Pavuk

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**Abstract:** Introduction: We conducted a follow-up study (ACHS II) of the Anniston Community Health Survey (ACHS 2005-7) in 2014. Participants were exposed to polychlorinated biphenyls (PCBs) concentrations that were about 3 times higher than in the general U.S. population and we observed significant associations between PCBs and hypertension. When endothelial cells are exposed to PCBs or other dioxin-like compounds in animal studies, inflammatory pathways may be activated and lead to increased expression of cytokines, which can contribute to the development of atherosclerosis and hypertension. Methods: Hypertension status was defined as being on antihypertensive medication or having a systolic/diastolic blood pressure greater than 140/90 mmHg; 262 (77.5%) of 338 participants were hypertensive. Cytokines measured included number of interleukins plasminogen activator inhibitor-1 (PAI-1), transforming growth factor beta 1 (TGF- $\beta$ 1), and tumor necrosis factor alpha (TNF $\alpha$ ) HADK2MAG-61K and HADK1MAG-61K bead arrays (EMD Millipore, Billerica, MA). The polychlorinated dibenzo-p-dioxins (PCDD), dibenzofurans (PCDF), and non-ortho PCBs were measured using high-resolution gas chromatography/high-resolution mass spectrometry and expressed as dioxin toxic equivalents (TEQs, pg/g lipid). Linear regression models adjusting for age, sex, BMI, family history of high blood pressure, and smoking status were applied. Results and Conclusion: We found statistically significant associations between PCDD TEQ and TNF $\alpha$ , PAI-1, and with TGF- $\beta$ 1 and non-ortho PCB TEQ and mono-ortho PCBs TEQ among hypertensive individuals. These findings suggest that these chemicals may be related to endothelial cell damage which increases production of inflammatory cytokines, the suppression of fibrinolysis, or downregulate AMP-activated protein kinase activation. These findings need to be replicated in other human cohorts exposed to dioxin-like chemicals.

## **P02.3040. Exposure to Asbestos and Colorectal Cancer: A Meta-Analysis**

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**Abstract:** Background : The International Agency for Research on Cancer (IARC) concluded that there is limited evidence for a causal association between exposure to asbestos and colorectal cancer. This association, however, has been an old controversial. Objective : We performed a meta-analysis to quantitatively evaluate the association between exposure to asbestos and colorectal cancer. Methods : We searched for original articles in literature databases (PUBMED, EMBASE, Web of Science). Two authors independently reviewed articles and selected 42 cohort studies for meta-analysis Results : The overall pooled standardized mortality ratio (SMR) estimate for colorectal cancer was 1.11 (95% confidence interval, 1.00-1.24), with a high degree of heterogeneity (I2 = 66.1%). Our analysis of the studies that included only latent periods showed that the pooled SMR estimate was 1.08 (95% confidence interval, 0.93-1.24), with a high degree of heterogeneity (I2=71.0%). Conclusion : The overall pooled SMR of meta-analysis is statistically significant. However, the effect size was small, and SMR was not statistically significant when confined to the studies including latency. The evidence did not meet the established criteria for making a judgement for the existence of a causal association between asbestos and colorectal cancer.

**P02.3050. County-Level Radon and Incidence of Female Thyroid Cancer in Iowa, New Jersey, and Wisconsin, U.S.A.**

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**Abstract:** Background: Few studies have investigated the association between radon and thyroid cancer despite the sensitivity of the thyroid gland to radiation. Our goal is to investigate the association between county-level radon and incidence of female thyroid cancer in the US States of Iowa, New Jersey, and Wisconsin. Methods: Thyroid cancer incidence data were provided by individual state cancer registries and span 1990-2013. Radon data come from a publicly available third-party database, AirChek, accessed in 2017. We tabulated the percent of radon above four picocuries per liter and the female thyroid cancer incidence rate in each county. Quantile maps were constructed, and an ordinary least-squares regression model was run using Geoda 1.10.0.8 (Chicago, IL, USA). Results: No association was observed between county-level radon and incidence of female thyroid cancer in any of the States: New Jersey ( $\beta = 0.06$ ,  $p = 0.23$ ); Iowa ( $\beta = -0.07$ ,  $p = 0.07$ ); or Wisconsin ( $\beta = -0.01$ ,  $p = 0.78$ ). A spatial regression model was considered, but the Moran's I of the residuals from each of the models was not significant, so no spatial term was required. Discussion: In this county-level ecological study across three different States in the US, we did not find an association between elevated radon and thyroid cancer incidence in women. While this ecologic study reports null findings, due to the ecologic fallacy, individual-level studies of this association may still be warranted.

## **P02.3060. Liquid Liver Biopsy in Residential Cohort Exposed to Polychlorinated Biphenyls Is Consistent with Steatohepatitis**

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**Abstract:** Introduction. Polychlorinated biphenyl (PCB) exposures have been associated with toxicant associated steatohepatitis (TASH) in animal models and suspected TASH in epidemiological studies including the Anniston Community Health Survey (ACHS). MicroRNAs (miRs) are non-coding RNAs that maintain cellular homeostasis and potentially mediate responses to environmental exposures. A 'liquid liver biopsy' was performed by serum miR profiling in PCB-exposed ACHS participants. Materials and Methods. ACHS participants, 152 (76 with and without suspected TASH), were evaluated. Suspected TASH was defined as serum cytokeratin 18 (CK18) M65>300 U/L and M30<200 U/L. Participants were stratified by sex. Sixty eight (68) targeted hepatotoxicity miRs were profiled in serum (Fireplex miRNA multiplex assay, Abcam). Serum adipocytokines and HOMA-IR were measured. Adjusted linear regression models examined relationships between the miRs and suspected TASH, CK18, PCBs, and adipocytokines. Ingenuity Pathway Analysis (IPA) was also performed. Results. Eight miRs were associated with suspected TASH. Four were upregulated (miR-22, -122, -320, and -375) and 4 were downregulated (miR -21, -92a, -223, and -410). Two miRs were associated with PCB exposures (let-7d and miR-181), including one which was also associated with increased CK18 M65 (let-7d). IPA demonstrated enrichment in pathways associated with liver steatosis, hyperplasia, decreased albumin, and HCC. Of the 8 miRs associated with suspected TASH, 4 miRs were also associated with IL-6, IL-8, PAI-1, adiponectin and resistin; while 3 miRs were also associated with HOMA-IR. Conclusions. 'Liquid liver biopsy' in subjects with suspected PCB-related TASH was consistent with steatohepatitis. Specifically, alterations in pathways related to steatosis, injury/death, inflammation, liver function, and hepatocarcinogenesis were detected. The results require histologic validation as well as confirmation in other cohorts.

**P02.3080. Environmental Exposure to Cadmium and Elevated Liver Enzymes in General Population in Republic of Korea**

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**Abstract:** INTRODUCTION: Cadmium (Cd) is a well-known toxicant, but there is a lack of epidemiological studies that have been conducted to clarify the effect of environmental Cd exposures on abnormal liver function in general population. We aimed to examine the association between Cd levels in blood and elevation of liver enzymes in adults and adolescents, from national representative data. METHODS: We analyzed the nationally-representative and cross-sectional survey data from 8,533 adults and 3,347 adolescents in the Korean National Health and Nutrition Examination Survey 2010-2013 and 2016. The concentration of Cd in blood was classified as the quintile in both adults and adolescents. Abnormally elevated liver enzymes were defined as a ALT $\geq$ 40IU/L, AST $\geq$ 40IU/L, and GGT $\geq$ 30IU/L. We evaluated associations between blood Cd concentration and serum liver enzymes levels (ALT, AST, and GGT) by performing multivariable logistic regression analyses for the survey data adjusted for covariates: Age, sex, alcohol consumption, smoking status, obesity, physical activities, or socioeconomic status. RESULTS: In adults, exposure to the highest quintile of blood Cd had a significant association with abnormally high liver enzymes (OR, 2.09 [95% CI: 1.43, 3.05] for ALT; 1.94 [1.14, 3.28] for AST; 1.80 [1.15, 2.83] for GGT; all p-trends<0.05), comparing to the lowest. In adolescents, there was a significant association between exposure to the highest quintile of blood Cd and elevation of ALT (OR, 2.97 [95% CI: 1.01, 8.73]; p-trend<0.05), but no association in AST and GGT (2.07 [0.58, 7.40] for AST; 4.13 [0.65, 26.17] for GGT; all p-trends>0.05). CONCLUSIONS: This present study supports that the environmental Cd exposure may induce the elevation of liver enzymes in general population and it could be helpful to establish reliable regulation to Cd exposure for public health. ACKNOWLEDGEMENT: J.K. and E.P. contributed equally to this work.

## **P02.3090. Geographic Patterns in U.S. Lung Cancer Incidence by Histologic Type**

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**Abstract:** Background: Geographic variation in U.S. lung cancer incidence overall and by histologic type has not been explored. Investigation of these patterns may inform etiologic hypotheses about environmental risk factors. Methods: Using North American Association of Central Cancer Registries (NAACCR) high quality state data, we calculated age-adjusted sex-specific lung cancer incidence rates for whites, overall and for microscopically-confirmed adenocarcinoma, squamous cell carcinoma, and small cell carcinoma cases by state and health service area. We investigated incidence patterns during 2004-2014 and trends from 2004-2009 to 2010-2014. Results: Cases from 43 states plus the District of Columbia were included. Total lung cancer incidence rates per 100,000 males were highest in Kentucky (104.6), Mississippi (94.1), and Arkansas (90.2). Female rates were highest in Kentucky (69.3), Delaware (60.0), and West Virginia (59.0). Rates for males and females were lowest in Utah. Lung cancer rates declined notably among males in California, Texas, and Hawaii and modestly in the southeast; female rates increased in Kentucky, Maine, New York, and Florida and declined in Texas, Arkansas and the west coast. Male adenocarcinoma rates remained high in the southeastern U.S. with elevated rates in North Dakota, South Dakota, Iowa, Nebraska, Iowa, and Pennsylvania. Female adenocarcinoma rates increased in New York, Connecticut, Massachusetts, New Jersey, Kentucky, Florida, and California. Rates of squamous cell carcinoma were stable, while small cell carcinoma rates declined among both males and females. Conclusions: This analysis reveals U.S. areas with high adenocarcinoma rates where smoking rates were not historically high. Analyses using locally-weighted and Poisson regression approaches will compare smoking-adjusted rates between regions. Insight into risk similarities and differences by refined geographic, demographic, and smoking characteristics will be presented.

**P02.3100. The Environment-Wide Approach for the Assessment of the Effect of Environmental Stressors on Overweight, Obesity and Diabetes: A Study on Singletons for the Heals Project**

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Abstract: One of the main aims of the HEALS project is to unravel, through an exposomic approach, the development of metabolic diseases. The objective of the present study was to investigate the relationship between body burden from endocrine disrupting chemicals (EDCs) exposure (Holtcamp, 2012; La Merrill and Birnbaum, 2011) and the onset of overweight, obesity and diabetes, in view to promote preventive actions. Data was obtained from several pre-existing European cohorts (REPRO-PL, PI1, PI2, IMCA, SEASD, CCM, PHIME-CRO, PHIME-SI, G21, EPITeen, EDEN, CHISQ200 and MAAS). They were harmonised and cleaned to obtain a final dataset of 28,608 individuals. To replace missing values, a multiple imputation methodology was used. The EWAS analysis employed a survey-weighted logistic regression method with a Bonferroni correction to adjust the probability values and counteract the problem of multiple comparisons. As dependent variables, the health outcomes considered were overweight (BMI $\geq$ 25), obesity (BMI $\geq$ 30) and type-2 diabetes mellitus. As independent variables, 70 environmental assays and other demographic factors, at different periods of life were included. Obesity was found to be positively and significantly associated with PM10 (OR=1.174, p-value=0.005), NO<sub>2</sub> (1.276, 0.030), PCB118 (2.687, 0.026), zinc (1.098, 0.021) and several class of phthalates like MEHP (1.095, 0.026). A negative association was observed for some stressors like brominated diphenyl ether BDE153 (0.980, 0.001) and cadmium (0.868, 0.001). Comparable results were obtained for overweight and diabetes. Our EWAS analyses confirm potential association between multiple environmental factors and overweight, obesity and diabetes. Whether mechanisms underlying metabolic changes depend on adipocyte proliferation and differentiation, glucose homeostasis, insulin release or behaviour (traffic pollution may also lead to less physical activities and sedentary lifestyle) needs to be further investigated.

**P02.3110. Association between Concurrent Exposure to Dioxin and Mercury and Metabolic Syndrome in an Endemic Area in Taiwan**

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**Abstract:** Introduction: Both dioxin and mercury are related to the development of metabolic syndrome (MetS). However, studies on the effect of concurrent to dioxin and mercury on metabolic syndrome are limited. We conducted a study in Taiwan to evaluate the effect in an endemic area where resident were exposed to both polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and mercury released from a factory. Methods: We recruited participants from residents in the endemic area and defined serum PCDD/Fs levels  $\geq 20$  pg WHO98-TEQDF/g lipid and mercury levels  $> 20$  ppb as high exposure mercury levels. MetS was defined as meeting three of the following: fasting glucose  $\geq 100$  mg/dL or under treatment for diabetes, waist circumference  $\geq 90$  cm in men or  $\geq 80$  cm in women, triglycerides  $\geq 150$  mg/dL or under treatment for elevated triglycerides, high-density lipoprotein  $< 40$  mg/dL in men or  $< 50$  mg/dL in women, and blood pressures  $\geq 130/85$  mmHg or under treatment for hypertension. Uric acid  $\geq 7$  mg/dl was defined as high level. Results: In the 2758 participants, 785 patients of MetS were identified. We observed positive associations of both high dioxin level and high mercury level with MetS. After adjusting for sex, uric acid, and age, we found high dioxin levels (adjusted odds ratio [AOR] = 1.39, 95% confidence interval [CI]: 1.12-1.73), high mercury levels (AOR = 1.59, 95% CI: 1.14-2.23), older age (AOR = 2.81, 95% CI: 2.21-3.582 for 40-64 year and AOR = 4.57, 95% CI: 3.42-6.10 for age  $\geq 65$  year), and high uric acid levels (AOR = 2.31, 95% CI: 1.87-2.87) were independent predictors for MetS. Conclusions: Both exposures to PCDD/Fs and to mercury were associated with MetS, independent of age and uric acid.

## **P02.3130. Exposure to Electromagnetic Fields and the Risk of Brain Cancer**

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Abstract: Electromagnetic fields (EMF) emitted by mobile phones, wireless devices, transmission towers and other sources are a cause for concern. The purpose of this study is to review the current data for exposure to EMF and known biological effects and evaluate the mechanistic possibility of the development of brain tumours, possibly through epigenetic modifications. Systematic review of literature was conducted using pre-determined criteria to collate the relevant literature. Scientific research suggests that EMF in contact with biological tissues is able to induce changes in cell cycle, cell death and alterations in protein and gene expression in laboratory studies. Other health effects including altered glucose metabolism, increased calcium flux, reduced cognitive function, melatonin disruption, alterations in DNA and brain tumours have been suggested. The current epidemiological data suggest a weak non-conclusive association between exposure to EMF primarily from mobile phones and brain cancers. Epidemiological studies also inconclusively suggest the development of acoustic neuroma, glioma, meningioma and ipsilateral use of mobile phones with a latency period of over 10 years from exposure to EMF. However, toxicology data from in-vivo and in-vitro studies indicates that the development of brain tumor is possible and plausible.

## **P02.3140. Association between Blood Lead Levels and Liver Fat Accumulation in Young Adults**

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**Abstract:** Background: Recent evidence has linked lead exposure to Non-Alcoholic Fatty Liver Disease (NAFLD) as liver is a target organ and a repository of the metal. The aim of this study was to estimate the association between lead exposure during childhood and the amount of fat in the liver of Mexican young adults. Methods: This study includes 94 participants representing a subsample from the first birth cohort of the ELEMENT project started in 1994. Data include the historical venous blood lead measurements during childhood and the recent quantification of fat in the liver 22 years after the cohort started (2016). Four blood lead level (BLL) determinations were available from participants annually between 1 to 4 years of age; average of BLL was analyzed as continuous and as a categorical variable (>5 and >10 mcg/dL). Magnetic resonance imaging was used to quantify the percentage of fat in the liver. Models were adjusted for: birth weight, sex, SES, and current: Age, alcohol intake, smoking habits, energy intake, and BMI. Results: Participants ranged in age from 21 to 22 years; 53% were male. Median BLL in childhood was 7.5mcg/dL (IQR 5.8, 9.3), 86.3% presented lead values >5mcg/dL and 18.5% >10mg/dL. The median amount of fat in the liver was 1.5% (IQR 0.7-3.7); 19% presented with more than 5% of fat in the liver, considered as NAFLD. The adjusted linear regression models showed that for each extra unit of blood lead the percentage of fat in the liver increases 0.84% (CI 0.34, 1.32). Having BLL above 5 mcg/dL was not statistically significantly associated with fatty liver, but having more than 10 mcg/dL BLL during childhood was associated with higher liver fat (b= 6.18%, 95%CI 3.16, 9.21) compared to those below 10 mcg/dL. Conclusions: Lead exposure may lead to a higher percentage of fat accumulated in the liver during adulthood among those with elevated BLL in childhood. This association may be mediated through direct or indirect effects of lead on obesity.

## **P02.3141. Association between Fluoride Concentration in Public Water Supplies and Beneficial and Adverse Health Outcomes in England: An Ecological Study**

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Abstract: The protective effect of community water fluoridation (CWF) on caries is established, but secular changes may modify its impact. Relationships with adverse health outcomes have also been alleged. We aimed to determine the association between concentrations of fluoride in public water supplies (PWS) and dental caries indicators, and certain adverse health-outcomes to monitor the health effects of CWF in England. We estimated exposure to CWF and PWS fluoride concentrations from national PWS monitoring data, using Geographic Information Systems and water supply boundaries. We categorised mean period exposure into <0.1, 0.1-<0.2, 0.2-<0.4, 0.4-<0.7, and  $\geq 0.7$ mg/l. We obtained area-level health outcome and confounder data from routine data sources. We used multivariable regression to determine the association between fluoride and health outcomes. The association between fluoride level and caries prevalence/severity varied by quintile of socioeconomic status (SES) ( $p < 0.001$  for interaction). Odds of caries, and of severe caries in five-year-olds, fell with increasing category of fluoride concentration in each quintile of SES ( $p < 0.001$  to  $p = 0.003$ ). There was a negative trend between increasing fluoride concentration and dental extractions ( $p < 0.001$ ). There were sporadic positive associations ( $p < 0.05$ ) between varying fluoride concentrations and Down's syndrome and kidney stones, but without evidence for a trend or threshold. There was a negative association with bladder cancer at the highest fluoride concentration. The association with hip fracture varied in direction by age ( $p < 0.001$ ), with a small positive association (RRs 1.03-1.05,  $p = 0.08$  or below) in adults aged 80 years+ at each fluoride concentration relative to <0.1mg/l. There was no strong evidence of an association with osteosarcoma. Exposure to fluoride in PWS appears highly protective of caries and caries extractions. Our findings did not provide clear evidence of an association with the adverse health outcomes.

## P02. Biomarkers of Exposure and Effects 2

### **P02.3150. German Environmental Specimen Bank: Characteristics of 24-H Urine Samples and Their Relevance for Human Biomonitoring - Experience from 20 Years of Trend Research**

André Conrad

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**Abstract:** For documenting trends in human exposure, the German Environmental Specimen Bank (ESB) has been routinely collecting and archiving 24 h-urine samples from young adults at four sampling sites in Germany. In addition to pollutant concentrations, urinary creatinine (UC), specific gravity (SG), conductivity (CON) and total urine volume (UV<sub>tot</sub>) have been routinely recorded. It is known that the above-mentioned characteristics of 24 h- urine samples vary between individuals and over time and might affect data interpretation. To identify relevant differences and trends in these parameters, we analysed ESB data from 1997-2016 from 8,916 participants also with regard to the impact of sex, sampling site. Sampling sites do not substantially affect UV<sub>tot</sub>, UC, SG and CON. A significant increasing trend was revealed for UV<sub>tot</sub>. This increase is associated with UC, SG, and CON decreasing over time. Effects of normalization against these urine parameters were demonstrated for urinary Ca<sup>2+</sup> concentrations: From 1996-2016, Ca<sup>2+</sup> showed a significant decreasing trend over time. A normalization against UV<sub>tot</sub>, UC, or CON eliminated this trend. The known sex specific excretion for Ca<sup>2+</sup> is confirmed in this study. A normalization against UC, SG, or CON alleviated differences between sexes whereas a normalization against UV<sub>tot</sub> did not. To avoid misinterpretations in trend analysis and of sex specific excretion, the collection of 24-h urine samples and the calculation of the total daily excretion is recommended. Also if sampling is limited to spot or morning urine samples, the record of multiple urinary parameters should be considered for supporting data standardization. The suitability of these characterization may, however, vary by the analyte of interest, the study design, and the kind of urine sample taken. Funding by the German Ministry for the Environment (BMU) is gratefully acknowledged.

**P02.3160. Biomarker Assessment of Perfluoroalkyl Substance Exposure: Inter-Individual Differences Revealed by Use of Organic Anion-Inhibiting and Resin-Binding Drugs in a Community Setting**

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**Abstract:** Background: Perfluoroalkyl substances (PFAS) are man-made, environmentally persistent organic compounds. Their long serum half-life in humans contrasts with findings from laboratory studies in rodents, and has been attributed to species differences in the activity of organic anion transporter (OAT)-directed renal tubular excretion or reabsorption of PFAS. Drugs which can affect excretion help in understanding underlying mechanisms for the long half-life, support causal inference in health hazard assessment and potentially offer a means to reduce community burdens of exposure. Methods: We determined the serum concentrations of four long chain serum PFAS concentrations among participants from the community-based C8 Health Project taking the uricosuric OAT-inhibitor probenecid (23 subjects), and the bile sequestrant anion exchange resin cholestyramine (36 subjects). These were compared to concentrations in a large adult population not taking these medications, after adjusting for age, gender, body mass index (BMI), calculated glomerular filtration rate (eGFR) and water-district of residence. Results: Those taking the resin cholestyramine had significantly lower serum PFAS concentrations, notably over 10-fold lower for perfluorooctane sulfonic acid (PFOS). Probenecid was associated with a modest, not statistically significant increases in serum PFAS concentrations. Conclusions: Our data confirm that cholestyramine increases excretion of PFAS, the first time demonstrated in community settings. They also suggest that probenecid-induced OAT inhibition in humans has little effect upon PFAS excretion. The findings point to the need for increased focus on non-renal physiology when considering PFAS excretion kinetics and a possible means to decrease PFOS contamination in humans. The strong effect of cholestyramine on serum PFAS also points to research needs on impact on serum PFAS of individual differences in gut reabsorption.

## **P02.3170. Total X-Ray Fluorescence for the Analysis of Multiple Elements in Dried Blood Spots**

Veronica Rodriguez Saldana

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Abstract: Dried blood spots (DBS) have been hailed as a simple way to collect, transport and store biological (blood) samples for several analytical purposes. The technique is minimally invasive which makes it a cost-effective alternative to traditional venipuncture procedures. Despite this promise, there have been challenges in measuring analyte concentrations in DBS owing to small sample volumes, concentrations, and other factors. Total Reflection X-Ray Fluorescence (TXRF) may help overcome some these barriers, and thus the aim of this research was to develop and validate a novel method to perform a multi-element analysis (copper, zinc, selenium, iron, and lead) in DBS using TXRF. A TXRF-based method for multi-element analysis was validated by analyzing DBS from different human blood standard reference materials (SRM, Institut National de Santé Publique du Québec, INSPQ; n=7) with varying and known concentrations of elements. Percent recoveries, calculated by comparing DBS to known values, and coefficients of variation were analyzed for accuracy and precision. Stability of analyses was assessed by comparing results over 16 batch runs. The method was validated by quantifying the elements of interest in capillary whole blood and DBS collected from 49 healthy individuals. The limits of quantification of Cu, Fe, Pb, Se, and Zn were 5.08, 10.7, 3.45, 3.48, and 4.50 µg/L, respectively. The precision of the method was between 3.0-15.2% for the elements of interest. Percent recoveries for Cu, Zn, Se, and Pb using an entire 25 µL DBS of SRM were 106.7± 10%, 97.9± 11.9%, 105.5± 9.2%, and 80.8± 16.40%, respectively. These results show the potential of TXRF as an alternative analytical technique to quantify multiple elements in DBS samples. The results will be further explored with ICP-MS data.

## **P02.3180. Exposomic Biomarkers from the Residents in the Coastal Area of the Hebei Spirit Oil Spill**

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**Abstract:** Background/Aim Since the accident of Hebei Spirit oil spill in 2007, the repeated biological samples were collected from the Taean residents and their health status has been monitored; however, few chemicals were determined as exposure biomarkers. The aim of the present study is to identify exposomic markers of chemicals among the residents. Methods According to the oil-contaminated coastal area, exposure groups were assigned as high- and low-group. Six subjects from each provided urine samples at 2009, 2014, and 2016. Environmental chemicals in urine were screened with UPLC-qTOF-MS and determined by comparison with spectra of chemical standards and web-based chemical libraries. The levels of the analytes were expressed as the relative ratio with the average (1+2)-naphthol in urine. Results We compared the relative levels between the groups from all urine sample collected repeatedly. Among the high exposure group, (1+2)-naphthol was detected 1.5-fold more and their relative levels were 2.5-fold higher than control (low exposure group). Trans-, trans-muconic acid was detected more frequently in the low exposure group, but the relative concentrations were 1.2-fold higher in the high exposure group. N-Acetyl-S-(2,4-dimethylphenyl) -l-cysteine and N-Acetyl-S-(1-phenyl-2-hydroxy -ethyl) -l-cysteine showed higher detection frequency and 3-fold higher relative ratio in the high exposure group. Phthalate metabolites (mono-2-ethylhexyl phthalate), paraben, benzophenone-3, bisphenol F were also more in high exposure groups. However, the concentration levels of these compounds showed no association with any time span after the disaster and the variation of the levels was large. Conclusions The PAHs and VOCs metabolites seem related to the exposure area. Some environmental chemicals such as parabens and phthalates were also detected more in the high exposure group. In order to confirmation of their exposure sources, further studies are needed.

## **P02.3200. Characterization of Chemical Exposures in a Metropolitan Atlanta African American Birth Cohort Using Mass Spectrometry-Based Methods**

Priya D'Souza

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**Abstract:** Only a few population-based studies have been able to characterize environmental toxicant exposures in the United States. However, no such study has been conducted in the Deep South/Southeast, despite the fact that this region differs from others in climate, housing, population density, culture, and racial/ethnic composition. Little is known about how the pre- and post-natal exposomes of African American (AA) mother-infant pairs affect health and development because prospective studies examining these complex relationships are rare. We conducted a birth cohort study in a socioeconomically (SES) diverse pregnant AA population residing in metropolitan Atlanta. Using mass spectrometric methods, we characterized a portion of the exposome in a subset (N=56) of participants in order to understand the prevalence of exposures in this cohort. We measured concentrations of a broad suite of environmental toxicants in blood and urine samples including toxic heavy metals, brominated flame retardants, persistent pesticides, polychlorinated biphenyls, and poly- and perfluoroalkyl substances, as well as the metabolic forms of phenols, phthalates, parabens, nicotine, current-use pesticides, and polycyclic aromatic hydrocarbons. The metabolites of some phthalates, parabens, and pesticides were found to be significantly higher in this cohort than the general U.S. population, with lower SES participants tending to have higher levels. Our study is the first to characterize the environmental chemical exposome in an AA population in the Deep South/Southeast. The data suggest that environmental toxicant exposures are pervasive across metropolitan Atlanta and must be characterized further.

## **P02.3210. Exploration of Potential Biomarkers and Related Biological Pathways for P, P'-DDE Exposure in Maternal Serum**

Chisato Mori

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Abstract: Dichlorodiphenyldichloroethylene (p, p'-DDE) have been associated with adverse human reproductive and fetal developmental measures or outcomes from their endocrine-disrupting effects. In this study, we aimed to identify the biological pathways and potential biomarkers of p, p'-DDE exposure in maternal serum using metabolomics platform. This study was approved by the Biomedical Research Ethics Committee of the Graduate School of Medicine, Chiba University. The Chiba study of Mother and Child Health (C-MACH) consisted of three hospital-based cohorts. A total of 433 women consented to participate in C-MACH. Due to a small number of current and previous smokers in this study, these participants were removed. Finally, the remaining 67 mothers were used for analysis. Serum levels of p, p'-DDE and metabolome were analyzed using the GC-NICI-qMS and HILIC-MS/MS, respectively. The median concentration of p, p'-DDE in maternal serum were 400 pg g<sup>-1</sup> wet wt. The levels of p, p'-DDE in maternal serum were slightly higher than that of PCB levels analyzed in our previous study (350 pg g<sup>-1</sup> wet wt.). We used the gradient boosting model with the metabolome profile to predict exposure levels of p, p'-DDE (first quartile [Q1] and fourth quartile [Q4]) for pregnant women. Areas under receiver operating characteristic curves, as measured by 3-fold cross validation (AUCCV = 0.840) and against an external test set (AUCEXT = 0.833), indicated the accurate classification of Q1 and Q4 population. In maternal serum, the valine, leucine and isoleucine biosynthesis, betaine metabolism, and glycine, serine and threonine metabolism (FDR <0.10), indicating disruption of metabolic pathways by p, p'-DDE exposure in pregnant women. Interestingly, PCB and p, p'-DDE levels in maternal serum were strongly correlated; however, related biological pathways were not overlapped. Thus, more detailed studies are needed to clarify the difference of biochemical changes resulting from PCB and p, p'-DDE exposure.

## **P02.3220. Maternal Biomarkers Relevant to Pregnancy and Birth Outcomes**

James Gomes

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**Abstract:** Background: There is a need to elucidate specific mechanisms in-utero during pregnancy and to delineate the role of the biological markers. The expression of biological markers could help in understanding the effect of environmental exposures on pregnancy outcomes. This study aims to examine the role of biological biomarkers and the underlying mechanisms that may be associated with infant birth weights, gestational age and infant development in-utero. Methods: Electronic searches were conducted in relevant databases and all relevant papers were retrieved. Studies were selected if they evaluated maternal blood plasma/serum biomarkers proposed to influence adverse birth outcomes in the neonate. Data was extracted and odds ratios from each study and meta-analysis was conducted. Results: A total of 54 studies (35 for meta-analysis), including 43,702 women and collectively 50 biomarkers, were included in this study. The fixed effect point estimates for inflammation-related biomarkers were, 0.845(95%CI: 0.829-0.861,  $p < 0.0001$ ) for adverse birth outcomes and for hormone and growth factor-related biomarkers were 0.55(95%CI: 0.551-0.577,  $p = 0.0013$ ) for adverse birth outcomes. Pooled risk estimates for inflammation-related, hormone and growth factor-related biomarkers for preterm births were 0.845(95%CI: 0.829-0.861,  $p < 0.0001$ ) and 0.554(95%CI: 0.531-0.578,  $p < 0.0001$ ) respectively. Comparable risk estimates for delivery between 30 weeks and 37 weeks were 0.967(95%CI: 0.951-0.985,  $p < 0.0001$ ) and 0.759(95%CI: 0.759(0.657-0.861,  $p < 0.0001$ ) for inflammation related- and hormone and growth factor related- biomarkers respectively. Significant associations were seen between biomarkers and adverse birth outcomes with no apparent publication bias. Conclusions: The two subsets of plasma markers identified in this study (inflammation-related and growth factor/hormone-related) may serve as valuable tools in the investigation of maternal molecular mechanisms modulating adverse birth outcomes.

**P02.3230. Measuring the Responsome: Transcriptional Differences in mRNA Expression by Smoking Status and Obesity as Biomarkers for Human Sensitivity to Environmental Exposures**

Kristen Malecki

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**Abstract:** The responsome is the collection of all physiological responses that can be influenced by the multitude of chemicals and environmental stimuli to which humans are exposed. While many studies have begun to examine DNA methylation as an upstream marker of altered gene expression, transcriptional biomarkers derived from whole blood mRNA may also provide important insights into human sensitivity to environmental exposures and differential response across populations. Obesity has been shown to alter physiological responses to air pollution and smoking but underlying biological mechanisms are largely unknown. Few studies have explored mechanisms by which obesity alters human sensitivity to environmental exposures. Overall study goals were to investigate whole blood gene expression in smokers and non-smokers to examine associations between cigarette smoke and changes in gene expression by obesity status and test for effect modification. Relative fold-change in mRNA expression levels of 84 genes were analyzed using a Toxicity and Stress PCR array among 21-54 year old adults (n=50). Data on smoking status was confirmed with urinary cotinine levels. Adjusted models included age, gender, white blood cell count and body-mass index (BMI). Six differentially expressed genes were associated with smoking after adjustments for covariates. Obesity was associated with 29 genes differentially expressed compared to non-obese. Significant smoking/obesity interactions were observed comparing for four DNA damage related genes (GADD45A, DDB2, RAD51 and P53), two oxidative stress genes (FTH1, TXN), two hypoxia response genes (BN1P3IL, ARNT), and one gene associated with unfolded protein response (ATF6B). Findings suggest transcriptional mRNA may provide opportunities for measuring the responsome. Implications for risk assessments and consideration of underlying phenotypes, like obesity, that may modulate sensitivity of vulnerable populations to environmental exposures will also be discussed.

## **P02.3240. From Exposure and Health to Action: Human Biomonitoring in Two Flemish Hotspot Areas**

Elly Den Hond

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**Abstract:** Background In Flanders, the northern region in Belgium, there is long-term experience to perform human biomonitoring (HBM) studies in hotspot areas. The results of HBM campaigns can provide input for policy actions, both local and supra-local. Methods In Hoboken, children aged 1 to 12 years, living in the approximate neighbourhood of a metal refining plant, were sampled twice a year to measure blood lead through a capillary blood sample from 1978 to 2018. The industrial area 'Genk-Zuid' is the 3rd largest industrial area of Flanders. Both in 2010 and in 2016, biomarkers of exposure (heavy metals, PAHs, POPs) and biomarkers of effect (immune effects, DNA damage, hormonal disruption) were measured in 15-year old adolescents living close to 'Genk-Zuid', where air quality data showed frequent exceedances of the WHO guidelines. Results In Hoboken, results have raised awareness in the community, and have resulted in a working group with members of regional and local governments, industry, medical experts and citizens. The working group induces actions to lower emissions, remediate the area, and sensitize the general population for preventive actions. Individual results are a leverage to initiate personal guidance at different levels, i.e. prevention, action, treatment. In Genk-Zuid, the first HBM campaign in 2010 identified the major pollutants of concern, together with possible exposure routes, and paved the way to design a specific action plan. After 6 years of policy and action, the second HBM study in 2016 provided input for the evaluation and adjustment of the action plan. Throughout both campaigns, there was special attention for guidance and assistance in interpreting the individual results of the adolescents that participated in the study. Conclusion Human biomonitoring is a very powerful tool to initiate, apply and evaluate policy actions in local hotspot areas, both on an individual and a group level.

## **P02.3250. Levels of Contaminants in Human Populations in the Canadian Arctic**

Cheryl Khoury

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Abstract: Levels of environmental contaminants, which are transported to the Arctic via air/water currents, have been shown to be elevated in northern populations, primarily Inuit. For more than 25 years, the Northern Contaminants Program (NCP) has funded research in response to concerns about exposure to contaminants from traditional, northern indigenous diets. Recently, NCP completed a human health assessment report, which provides a summary of current knowledge regarding contaminants and human health in northern Canada. Data from NCP funded studies were compiled to summarize levels of contaminants among Inuit children, pregnant mothers, women of childbearing age, and adult men and women. Data was also used to identify time trends and provide regional descriptive comparisons. This assessment found that concentrations of contaminants are higher in Inuit from northern Canada relative to the Canadian general population. This is primarily due to dietary exposure to contaminants from the consumption of certain country foods such as marine mammals. Inuit populations living in Nunavut and Nunavik, where these country foods are typically eaten more frequently or in larger amounts, had higher levels of contaminants. Time trend data show declining levels of organochlorines and metals (such as mercury and lead), by up to 80% and 60% respectively, in pregnant Inuit women from Nunavik (1992-2013). Despite this, levels remain elevated compared to the Canadian general population. Since the completion of the assessment new projects have been funded and these will also be highlighted. Strong time trend data are available for Nunavik; however more information is needed in other regions. New chemical groups have emerged in the Arctic. While human exposure data is still limited, data is being generated through new research. Additional conclusions, knowledge gaps and recommendations for future northern studies are detailed in the NCP human health assessment.

**P02.3260. Positive Association between Urinary Concentration of Lead, Cadmium and Subclinical Atherosclerosis in Adolescents and Young Adults**

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**Abstract:** Backgrounds: Urinary cadmium and lead have been associated with hypertension and cardiovascular diseases (CVD) in large population studies. However, there are still limited information linking exposure to heavy metal with subclinical atherosclerosis, particularly in young population. Methods: From a nationwide mass urine screening for renal health, conducted in 1992-2000 among school children 6 to 18 years of age in Taiwan, we recruited 789 subjects to participate in the cardiovascular health examination in 2006-2008. In the present study we evaluated the association between urinary levels of cadmium, lead, chromium, manganese, iron, nickel, copper, and zinc with carotid intima-media thickness (CIMT) in a cross-sectional analysis of 739 adolescents and young adults. Results: CIMT at all segments of carotid arteries significantly increased with the urinary lead and cadmium in a dose-response relationship after adjustment for major CVD risk factors. Multivariate logistic regression analysis showed that higher quartiles of urinary concentrations of lead and cadmium were associated with a higher risk of thicker CIMT (greater than 75th percentile). Compared to subjects with the lowest quartile (Q1) of urinary lead, the adjusted odds ratios (aORs) (95% confidence interval (CI)) for thicker CIMT among subjects with higher urinary lead were 2.56(1.35-4.85) for Q2, 3.76(2.00-7.08) for Q3, and 17.64(9.32-33.39) for subjects at Q4. Comparing those with lowest urinary cadmium, the corresponding aORs (95% CI) were 1.48(0.77-2.85) for Q2, 4.68(2.57-8.52) for Q3, and 13.58(7.34-25.13) for subjects at Q4. Conclusion: Higher urinary concentration of lead and cadmium was strongly associated with subclinical atherosclerosis in adolescents and young adults.

## **P02.3280. Environmental Exposures during Early-Life and Child Blood Pressure: An Exposome Approach**

Martine Vrijheid

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**Abstract:** Introduction: There is growing evidence about fetal origins of hypertension but studies on the effect of environmental exposures during early-life are few and generally consider single exposures. This study aims to fill this gap using data collected from 6 European birth cohorts as part of the HELIX project. Methods: Blood pressure (BP) was measured among 1277 children at 7-10 years old using a standardized protocol. A wide range of prenatal (>90) and postnatal (>110) exposures were evaluated including the outdoor exposome (air pollution, built environment, meteorology, natural spaces, traffic, and noise), the individual exposome (biomarkers of exposure to chemicals), and lifestyle factors. Exposome-wide association study (ExWAS) using linear regression models adjusted for confounders and corrected for multiple testing was used. A variable selection method (DSA: Deletion, Substitution, Addition algorithm) was also applied. Results: ExWAS highlighted decreases in BP with markers of the built environment during pregnancy (e.g., IQR increase in facilities density [95% confidence interval]: -1.6mmHg [-2.5;-0.7]) and with child level of some organochlorine compounds (e.g., IQR increase in dichlorodiphenyldichloroethylene, DDE: -2.1mmHg [-2.9;-1.3]). The DSA selected the following exposures: 1) facilities density during pregnancy and maternal level of polychlorinated biphenyl 118 associated with lower BP, 2) maternal fish consumption, maternal level of bisphenol-A and outdoor temperature during pregnancy associated with higher BP, 3) child levels of DDE, hexachlorobenzene, and 2 phthalates metabolites, as outdoor temperature the day of examination, associated with lower BP, and 4) child levels of copper and perfluorooctanoate associated with lower BP. Conclusion: Quantifying the contribution of early-life environmental exposures to child BP is of critical importance since early intervention has the potential for significant benefits in reducing cardiovascular disease risk.

**P02.3290. HC-GC-MS Determination of the Inhalational Anesthetic Sevoflurane and its Specific Metabolite Hexafluoroisopropanol (HFIP) in Human Urine: Monitoring of Occupational Background Exposures**

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Abstract: Today, sevoflurane is one of the most used inhalational anesthetics in human surgery, due to favourable pharmacological properties. However, teratogenic and neurotoxic effects resulting from chronic sevoflurane exposure are being discussed controversially. We present a sensitive human biomonitoring method for sevoflurane and its specific exposure biomarker hexafluoroisopropanol (HFIP) in human urine, to monitor occupational background exposures in operating room staff. Fresh urine samples are hydrolyzed at 37 °C in sealed headspace vials with beta-glucuronidase (HP-2 from *Helix pomatia*). Isoflurane is used as internal standard. After hydrolysis, samples are frozen at -18 °C for at least two hours. Samples are analyzed by static HS-GC-MS, and chromatographic separation is performed on a DB-1 column. Enzymatic hydrolysis was complete after three hours, and hydrolyzed samples were stable for at least 48 hours. Calibration was linear up to 2,000 µg/L and limits of quantification (S/N=10) for sevoflurane and HFIP were 0.3 and 3 µg/L, respectively. Precision and recovery in anonymously collected native urine samples of exposed patients (high exposure) for sevoflurane and HFIP were 5.3 % and 96 %, and 5.5 % and 93 %, respectively. Precision and recovery in spiked pooled urine samples (low level; around limit of quantification) were similar. Compared to previously published methods, the presented method stands out due to the simultaneous determination of both analytes, going along with excellent sensitivity. In spite of occupational health measures, such as waste anesthetic gas scavenging, and leakage checks of anesthetic delivery systems, sevoflurane exposure of operating room staff is presumably inevitable. Due to the excellent sensitivity for HFIP, and the simultaneous determination of both biomarkers, the presented method can be applied in future biomonitoring studies as a reliable exposure assessment tool to monitor occupational background exposures.

## **P02.3300. Maternal Swimming Pool Exposure during Pregnancy in Relation to Birth Outcomes and Cord Blood DNA Methylation among Private Well Users**

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**Abstract:** Background: Swimming in pools during pregnancy may expose the fetus to water disinfection by-products (DBP). As yet, our understanding of the impacts on DBPs on the fetus is uncertain. Individuals with public water systems are typically exposed to DBPs through drinking and bathing, whereas those on private systems (such as wells), swimming in pools may be the primary exposure route. Objective: To investigate the effects of maternal swimming on birth outcomes and cord blood epigenetic changes in the New Hampshire Birth Cohort Study, a cohort of pregnancy women with households on private wells. Methods: Information about swimming in pools during pregnancy was obtained from 1,046 women via questionnaires. Swimming pool use and duration were modeled using linear regression with newborn weight, length, and head circumference (z-scores) and genome wide cord blood DNA methylation as the outcomes and with adjustment for potential confounders. Results: 16.5% of women reported swimming in a pool during pregnancy. Ever (vs. never) swimming was associated with larger head circumference (a z-score increase of 0.97 for first trimester and 0.73 for second or third trimester). Among swimmers, duration was inversely related to head circumference (-0.01 z-score per 10% increase in duration,  $p=0.02$ ). No clear associations were observed with birth weight or length. In a subset of the cohort with genome wide DNA methylation measurements, 18 CpG sites, mainly related to neurodevelopment, were associated with maternal swimming pool exposure ( $Q<0.1$ ). Conclusion: Our findings suggest swimming pool exposure may impact the developing fetus although longer-term studies are needed.

## **P02.3310. The Early-Life Exposome: Description and Patterns in Six European Countries**

Ibon Tamayo

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Abstract: The "Exposome" is defined as the set of all environmental exposures that can influence health from conception onward and it has been advocated to better understand the role of environmental factors on multifactorial and chronic pathologies. Understanding what a typical exposome looks like, including the structure of correlations between and within groups of exposure, is important for multiple steps in exposome research, including the planning of which exposures to measure and the development of statistical analysis protocols. Here we aimed to describe the early-life exposome using data from the Human Early-Life Exposome (HELIX) project, in which 212 environmental exposures were measured in pregnant mothers and their children at 6-11 years in 6 European birth cohorts. Specifically, we focused on the correlations between multiple environmental exposures, their patterns and their variability across European regions and across time (pregnancy and childhood periods). The highest correlation was within water DBPs group (0.7) in pregnancy and within meteorology group (0.7) in childhood period. Between groups correlation was lower and all of them were less than 0.25. Ten principal components explained 45% of the total variance in the pregnancy exposome. In the childhood exposome, ten component explained 39%. In the correlation between mother and children, coefficients were high (> 0.6) for many of the exposures estimated for the residential or school address, such as atmospheric pollutants, green space, noise, traffic. Other built environment factors such as facility density had lower correlations ( $r < 0.40$ ). We characterized the early-life exposome in 6 European birth cohorts with over 200 environmental exposures measured, encompassed in 18 exposure groups, during two time periods using common protocols and methodologies. Our first descriptive analyses highlight several of the characteristics inherent in exposome data and the difficulties they pose for exposome-health analyses.

**P02.3320. Intrusion of Chlorinated Hydrocarbons and their Degradation Products from Contaminated Soil: Measurement of Indoor Air Quality and Biomonitoring by Analysis of End-Exhaled Air**

Paul Scheepers

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Abstract: A historic contamination of chlorinated hydrocarbons from a former dry cleaning shop caused a soil contamination. These chemicals and their degradation products intruded into a book shop. Indoor air was characterized and the uptake by shop personnel was studied by biomonitoring. The aim of this study was to determine indoor air quality and uptake of soil contaminants and their degradation products. Samples of indoor air were collected over one week in the warm and cold season. Indoor air was sampled using canisters. End-exhaled air was collected from a male and female employee before the shop opened and after closure time. Chlorinated hydrocarbons were analysed with TD-GC-MS. Tetrachloroethylene (PER), trichloroethylene (TRI) and their degradation products 1,1-dichloroethylene (1,1-DCE), 1,2-trans-dichloroethylene (1,2-tDCE), 1,2-cis-dichloroethylene (1,2-cDCE) and methylene chloride (MC) were detected in ambient air. The carcinogen vinyl chloride was not detected. PER was the prime contaminant with week average air levels ( $\pm$ sd) of  $805.2 \pm 598.6$  in June 2016 and  $1031 \pm 499.3$   $\mu\text{g}/\text{m}^3$  in December 2017. Levels of MC, 1,2-tDCE, 1,2-cDCE and TRI were detected at concentrations below  $2.3$   $\mu\text{g}/\text{m}^3$ . When the barometric pressure was  $<1000$  mbar all substances of interest were detected in end-exhaled air but not anymore at  $>1000$  mbar. For PER the mean concentrations in end-exhaled air on each of the five workdays ( $\pm$ sd) increased from  $26.0 \pm 3.6$  and  $22.2 \pm 8.0$  ng/L in the morning to  $52.6 \pm 15.5$  and  $63.6 \pm 12.7$  ng/L in the evening, for the male shop owner ( $p < 0.05$ ) and female cashier ( $p < 0.01$ ), respectively. For MC and 1,1-DCE this pattern was not observed. Accumulation over the workweek was observed for MC but not for 1,1-DCDE and PER. Intrusion of soil contamination resulted in enhanced indoor air concentrations of chlorinated hydrocarbons above current indoor air standards. For PER in end-exhaled air an increase over the workday was consistent but accumulation over the week was not observed.

**P02.3330. Direct Analysis of Conjugated Metabolites to Evaluate Ortho-Phenylphenol (OPP) Exposure in Human Urine**

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Abstract: Ortho-Phenylphenol (OPP) has been widely used as a fungicide and preservative. Two facts: low dose studies have demonstrated a low toxicity in animals and humans but high dose exposure to this contaminant has toxic effects such bladder cancer. Thus far, monitoring of OPP exposure in the general population has been performed by measuring OPP after urine hydrolysis with the  $\beta$ -glucuronidase/arylsulfatase enzyme (mostly) and sometimes by the use of a mineral acid. We developed a sensitive, accurate and robust method using liquid chromatography-tandem mass spectrometry (LC-MS/MS) to specifically measure OPP metabolites excreted in human urine, the sulfate (OPP-S) and glucuronide (OPP-G) species. Comparative analysis of urine using a direct method and chemical hydrolysis method previously developed in our laboratory showed no significant difference in OPP concentrations. Moreover, a significant difference showed that underestimation of OPP level occurs when  $\beta$ -glucuronidase/arylsulfatase enzyme deconjugation is used. Then, different epidemiological studies may show different levels of exposure depending of methodological approach used.

## **P02.3340. Early-Life Environmental Exposure Determinants of Child Cognition and Mental Health**

Martine Vrijheid

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**Abstract:** There is increase concerns over child behavioral problems due to changing environments. Children are typically exposed to a long list of industrial chemicals that are neurotoxic but also to beneficial environmental factors such as spending longer periods surrounded by green spaces. In HELIX, we systematically tested the associations of an extensive set of exposures measured during pregnancy and childhood in 1,301 mother-child pairs, including outdoor and urban factors, chemical pollutants, indoor air pollutants, lifestyle and social factors. Cognitive function, emotional and behavioral problems were assessed at 6-11 yrs through the Raven Test Score (fluid Intelligence) and the standardized parent reports of child behaviour checklist (CBCL). An agnostic exposome-wide analysis considering each exposure independently was applied to assess exposome-neurodevelopment associations. Initial analyses for behavioral problems identified one out of 92 prenatal exposures significantly associated and 4 out of 110 post-natal exposures after multiple testing correction. It included an increase in symptom incidence with maternal tobacco smoking (0.34 [0.19,0.48]), also observed with an increase in emotional problems (0.20 [0.06,0.34]). No prenatal exposures remained associated with cognition after correction. In the child's exposome, child organic food intake (1.33 [0.64, 2.02]) was associated with Raven score and healthy diet (KIDMED index) was related with decreased symptoms in behavioral problems (-0.13[-0.19,-0.07]) but indoor air pollution was related to increased symptoms. These preliminary findings showed beneficial associations of child lifestyle factors with cognitive and behavior outcomes but also raised particular concerns for smoking and indoor air pollutants. Further analyses with other cognitive and behavior domains and population stratification will give us a major picture of the exposome effects.

## **P02.3350. Daily Intakes of Phthalates among Japanese Children**

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**Abstract:** [Background] Phthalates have been widely used as plasticizers primarily for polyvinyl chloride (PVCs) as well as solvents in consumer products. They are ubiquitously present in our surrounding environment. It has been found that the phthalates and their metabolites have effects on reproductive functions and allergic reactions. Children's exposure to phthalates is not well studied in Japan. The aim of this study was 1) to estimate daily intakes of phthalates among Japanese children and 2) to elucidate routes of exposure. [Methods] Preschool children at the age of 2-7 (n = 104) were recruited. Indoor dust and air (24 hours) samples were collected from their houses. Duplicate diets (one day) and 24-hour pooled urine were sampled. Indoor dust, air, and diet samples were analysed for phthalates (di(2-ethylhexyl) phthalate (DEHP), dibutyl phthalate (DBP) and butyl benzyl phthalate (BBzP)) by gas chromatography tandem mass spectrometry (GC-MS/MS). Urine samples were analysed for phthalate metabolites using liquid chromatography tandem mass spectrometry (LC-MS/MS). [Results] Medians of estimated daily intakes of DEHP, DBP (DnBP+DiBP), and BBzP were 2.9, 1.7, and 0.03 µg/kg/day, respectively. Ninety five percentile of those exposure were 9.6, 8.3, and 0.18 µg/kg/day, respectively. Daily intakes of DEHP and BBzP did not exceed the Japanese Tolerable Daily Intakes (TDIs). In contrast, 9.6% of children had daily DBP intakes beyond the Japanese TDI of 5 µg/kg/day. Urine MiBP levels highly correlated with DiBP concentrations in indoor air (r = 0.75), and moderately correlated with that in indoor dust (r = 0.60) and diet (r = 0.43), suggesting the major route of exposure to DiBP was indoor air. Little correlation was found between urine MEHP and DEHP in diet, indoor air and indoor dust. However, we found elevated DEHP concentrations in indoor dust (median: 1700 µg/g), indicating that the indoor dust can contribute to the DEHP exposure.

## **P02.3360. Lessons Learnt from the First Results of the French National Biomonitoring Program**

Clémence Fillol

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**Abstract:** The French biomonitoring program consists now of two distinct cross-sectional national biomonitoring surveys: A perinatal component based on a selection of pregnant women enrolled in the French Longitudinal Study since Childhood (Elfe), in 2011 and a general population survey (children and adults) coupled with health examinations and with a nutritional component: Environment, Health, Biomonitoring, physical Activity, Nutrition (Esteban), in the period 2014-2016. The results of the perinatal component of the national biomonitoring program describe the french women exposure in France in 2011 and give us the first trends for inorganics and organics pollutants comparatively with other countries. All these results are now available and reference values for this population of french pregnant women have been established. These results need to be confirmed by the results in general population (1104 children and 2503 adults) that will be available in Esteban study in 2018. In the presentation of this program, it will be proposed to explain the last results and the perspectives of the program as for example monitoring time trends in biomarkers levels, monitoring the impact of public health policies and regulations aiming to reduce environmental exposures to chemicals and challenges about the integration of prevention in our studies. With the experience of these first biomonitoring surveys in France, we will be able also to identify the public health issues that are emerging for future surveys.

## **P02.3370. Exposure to Polycyclic Aromatic Hydrocarbon in Women Living in the Chinese Cities of Baoding and Dalian Regions Revealed by Hair Analysis**

Brice Appenzeller

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**Abstract:** Polycyclic aromatic hydrocarbons (PAH) are produced from incomplete combustion of organic matter and released as environmental contaminants from activities such as transports, wood combustion, coal-fired power plants. In numerous urban areas worldwide, the levels of PAH exposure are considered critical regarding public health issues. The possibility to detect PAH and PAH metabolites biologically incorporated in human hair was demonstrated and proposed as biomarkers of exposure. Nevertheless, the possibility to distinguish different levels of exposure between different populations is still needed to validate the relevance of hair analysis in epidemiological studies. In this work, hair samples were collected from 204 women from two cities in China based on one year Air Quality Index history from governmental data (Baoding as polluted city and Dalian less polluted city). 8 out of the 15 parent PAH and 7 out of the 56 metabolites analyzed in this study were detected in all the samples. The highest concentrations in hair were observed for phenanthrene (4.2 to 889 pg/mg) > fluoranthene (1.05 to 204 pg/mg) > pyrene (3.2 to 124 pg/mg) for parent PAH, and for 9-OH-fluorene (0.04 to 1.78 pg/mg) > 2-OH-naphthalene (0.68 to 811 pg/mg) > 1-OH-anthracene (0.24 to 10.9 pg/mg) for metabolites. 14 parent PAH and 15 metabolites presented a significantly higher concentration in the hair samples collected from Baoding, as compared to Dalian. The median concentration of parent PAH was from 1.5 to 2.8 times higher in the hair of the subjects from Baoding than in subjects from Dalian and that of PAH metabolites was from 1 to 2.3 times higher. The study of inter-chemical associations revealed similarities and differences between the two areas, suggesting common and different sources of exposure depending on PAHs respectively. The results confirmed the relevance of hair analysis to identify qualitative and quantitative differences in PAH exposure between populations from different areas.

## **P02.3380. A Review of Serum Perfluorooctanoic Acid (PFOA) Concentrations over a Four-Year Period**

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Abstract: Perfluorooctanoic acid (PFOA) is a synthetic perfluorochemical used in the production of fluoropolymers. Although phased out from emission and product content by manufacturers in the U.S. since 2015, PFOA is a persistent chemical that remains in the environment. Exposures to the general population typically occur through drinking contaminated water or from using PFOA containing products. On occasion, our laboratory is asked to test serum samples for PFOA. A review of our data over the past 4 years (2014 - 2018) revealed 2711 serum/plasma samples tested from individuals with unknown PFOA exposures. These samples were assayed using HPLC separation with negative-ion electrospray tandem mass spectrometry (LC-MS/MS). The samples were prepared for analysis by adding an analyte specific isotope as an internal standard with subsequent protein precipitation. The analytical measurement range was 0.5 to 100 ng/mL. Of the 2711 samples tested, 29 were less than our reporting limit of 0.5 ng/mL. The average ( $\pm$  S.D.), median, range, and 95th percentile of the PFOA serum concentrations from these data were 28.6 ( $\pm$  268) ng/mL, 5.8 ng/mL, <0.5 - 8200 ng/mL, and 62 ng/mL, respectively. The range of ages for the individuals tested was 10 to 95 years, average of 59 ( $\pm$  15) years. The number of samples from males was 1282. Their serum PFOA levels averaged ( $\pm$  S.D.) 42.3 ( $\pm$  377) ng/mL with a range of <0.5 - 8200 ng/mL. The geomean, median, and 95th percentile for these men were 8.0 ng/mL, 7.0 ng/mL, 76 ng/mL, respectively. From the population data, there were 1402 samples from females. For these women, the average ( $\pm$  S.D.), geomean, median, range, and 95th percentile PFOA serum concentrations were 15.4 ( $\pm$  87.5) ng/mL, 5.5 ng/mL, 5.0 ng/mL, <0.5 - 2200 ng/mL, 47 ng/mL, respectively. These PFOA results generally appear to be higher than values observed in other studies of the U.S. population.

## **P02.3390. A Cross-Over Health Intervention Trial of Children Consuming an Organic Diet**

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**Abstract:** Introduction: The effectiveness of a systematic organic diet in improving key parameters of health in human studies has not been well studied. The objective of this study was to determine the intervention effectiveness of an organic diet in significantly reducing urinary pesticide metabolite concentrations and concomitantly affecting biomarkers of inflammation and oxidative stress in children. Methods: A 2 x 2 cluster-randomised cross-over trial at subject level study was designed for healthy children (n=150, 11-12 years old) from families historically consuming a conventional diet (>80% of weekly diet). The study period consisted of a 40-day conventional diet arm and a 40-day organic diet arm. Diaries were used to record the consumed diet and extent of compliance. A total of five morning urine voids samples per child in select time points of both conventional and organic phases were collected. Select metabolites of neonicotinoid/pyrethroid pesticides were monitored in children's urine using tandem mass spectrometry. Biomarkers of oxidative stress/inflammation and creatinine were measured in urine (isoprostane 8-iso-PGF2a and 8-OHdG) using immunoassay kits. Linear mixed-effects models of the biomarkers of effect were constructed to evaluate the main effects of organic diet and biomarker of exposure to pesticides accounting for both between- and within-subject variability. Results: The effect of organic diet on the biomarkers of oxidative stress/inflammation accounting for known confounders will be presented. Conclusions: To the best of our knowledge, this is the first time that the concomitant assessment of biomarkers of effect (oxidative stress/inflammation) along with biomarkers of exposure to pesticides in children systematically consuming an organic diet has been performed.

## **P02.3410. The Use of Dried Blood Spots for Mercury Assessment in Population-Based Research**

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**Abstract:** Dried blood spots (DBS) represent an alternative and minimally invasive method for classical venous blood sampling especially in field-based research since there is no need for specialized equipment, cold-chain handling, and phlebotomists. There is a growing number of studies studying the use of DBS to assess exposure to Methylmercury (MeHg) and Total Mercury (THg) using samples collected under controlled laboratory conditions, but the method has not yet been validated under field-based research. The present study aims to validate the use of DBS as a tool for mercury assessment in populations with different levels of exposure to mercury compounds. Here we explored a number of factors in two field-based studies: A) DBS samples and field blanks were collected in an Artisanal and Small-Scale Gold Mine (ASGM) area in Colombia (n=55); and b) paired DBS-blood samples were obtained from e-waste workers (n=20) in Ghana and a set of DBS were created with the whole blood under laboratory conditions. In all cases, three DBS punches of 3mm ( $\approx 18\mu\text{l}$ ), blank paper, and  $18\mu\text{l}$  of whole blood were acid digested and analyzed for MeHg and THg. Focusing on the e-waste workers, MeHg concentrations were mean=  $1.07 \pm 0.60 \mu\text{g/L}$  in whole blood and DBS, and mean=  $0.14 \pm 0.06 \mu\text{g/L}$  for the blanks samples. The results showed no significant differences between DBS created in the laboratory and collected in the field (paired t-test  $p=0.685$ ) and their respective blanks (paired t-test  $p=0.536$ ). Paired DBS-blood samples showed a high correlation ( $r^2=0.95$ ). We are currently analyzing the ASGM samples for MeHg and all the samples for THg mercury. The results are expected to increase our understanding of DBS as a potentially novel means to assess mercury exposure. Which could have immediate applications in established programs such as newborn screening and demographic health surveys

## **P02.3420. The Establishment of Simultaneous Analysis Method for Metabolites of Phthalates and Dinch in Human Urine by UHPLC-MS / MS**

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Abstract: Phthalates are plasticizers that are used to make plastics flexible, and are widely used in medical devices, toys, building materials, plastic products, various chemical products. There are many kinds of phthalates such as DBP, DEHP, DINP, DIDP. and It has been reported that it causes endocrine disruption. For this reason, the United States, the European Union and other countries around the world began to regulate the use of phthalates. Phthalates have been regulated and replaced with new compounds such as DINCH. DINCH is now widely used worldwide and is expected to have wide exposure to humans. It is also unclear how DINCH will affect the human body. Therefore, it is important to grasp the degree of exposure of phthalates and DINCH in humans in advance. This study is to establish a method for simultaneous analysis of metabolites of urinary phthalate and DINCH by UHPLC-MS/MS to determine the degree of exposure of phthalates and DINCH. The analysis substances are total 23 metabolites including 20 metabolites of phthalate and MINCH, OH-MINCH, and MEHTP which are metabolites of DINCH and DEHTP. Urine was prepared using enzymatic deconjugation with the  $\beta$ -glucuronidase followed by solid-phase extraction. The samples were analyzed by UHPLC-MS/MS. To verify accuracy and precision, spikes the standard solution into each 7 urine samples to a final concentration of 0.5, 5, 50 ng/mL, and validated for 3 days. As a result of confirming accuracy and precision, the accuracy was 82-109%(intra-day) and 85-105%(intra-day). Precision was less than 20%. The detection limit were 0.14-0.66 ng/mL and the linearity of the calibration curve was appropriate. This method can be used to investigate the human exposure of phthalates and DINCH.

## **P02.3430. Metabolomics of Childhood Exposure to Perfluorooctanoic Acid: A Cross-Sectional Study**

Joseph Braun

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**Abstract:** Background: Exposure to perfluorooctanoic acid (PFOA), a synthetic and persistent chemical used in commercial and industrial processes, is associated with reduced birth weight, increased adiposity, dyslipidemia, and liver injury. These diverse toxic effects suggest that PFOA elicits multiple biological responses. Identifying the metabolic changes induced by PFOA exposure could enhance our understanding of potential biological mechanisms. Study Objective: To identify metabolic changes associated with serum PFOA concentrations in 8-year old children using a metabolome-wide association study (MWAS). Methods: Using venous blood samples collected from 120 8-year old children in Cincinnati, OH, we quantified serum PFOA concentrations and performed untargeted metabolomic profiling by liquid chromatography-high-resolution mass spectrometry. We evaluated metabolic variations associated with PFOA concentrations using linear regression and false discovery rate (FDR) <20%. We identified associated metabolites with the METLIN mass spectral database and metabolic pathway enrichment analysis. Results: At FDR<20%, higher serum PFOA concentrations were associated with 239 detected chemical signals; 130 were positive associations. Initial annotation of the mass spectral data showed that both endogenous metabolites and perfluoroalkyl chemicals were associated with PFOA exposure. Using untargeted metabolomics, we detected PFOA, perfluorooctanesulfonic acid, and additional signals consistent with fluorinated chemicals. Biological alterations associated with PFOA concentrations included keratin sulfate degradation and metabolism of purine, caffeine, Vitamin E, linoleate, urea cycle/amino groups, glyoxylate, dicarboxylate, and galactose, consistent with changes to immunological, oxidative stress and catabolism pathways. Conclusions: This is the first study to perform a MWAS with PFOA exposure in children and provides new insights into the biological responses associated with PFOA exposure.

**P02.3440. Cross Validation of Biomonitoring Methods for Polycyclic Aromatic Hydrocarbon Metabolites in Human Urine: Results from the Pilot Phase of the HAPIN Trial in Tamil Nadu, India**

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**Abstract:** Background: The Household Air Pollution and Intervention Network (HAPIN) trial aims to demonstrate the effects of a liquefied petroleum gas (LPG) intervention on health in biomass using homes across four low- and middle-income countries (LMICs). We report results from cross validation of a high performance liquid chromatography with fluorescence detection (HPLC-FLD) method for the measurement of polycyclic aromatic hydrocarbon (PAH) metabolites in human urine including 1-hydroxypyrene (1OHP) and 2-naphthol (2NAP) as biomarkers of PAH exposure, at the HAPIN trial site in India. Methods: A HPLC-FLD method was developed to analyze a set of 25 split human urine samples sent from the Laboratory of Exposure Assessment and Development for Environmental Research (LEADER) at Emory University, Atlanta, USA. LEADER measured the same analytes using liquid chromatography-tandem mass spectrometry (LC-MSMS). Results of these two analytical methods were compared using Bland-Altman plots. Subsequent urine samples collected from pregnant mothers (n=40) and adult women (n=40) during the pilot activities of HAPIN trial were also analyzed by HPLC-FLD. Results: The limits of detection for 2NAP and 1OHP were 0.52ng/ml and 0.65ng/ml, respectively. Bland-Altman analysis showed large 95% confidence levels for 2NAP with a bias of about 2.98ng/ml with HPLC-FLD data being lower than LC-MSMS data at higher concentrations. For 1OHP, the 95% confidence levels were fairly small with much smaller bias of 0.17ng/ml and better agreement when outliers were excluded. The mean concentrations ( $\mu\text{g/g}$  creatinine) and range of 2NAP and 1OHP in pregnant mothers were 25.8 (2.3-110.8) and 6.2 (0.25-24.1), respectively, and in adult women, 26.4 (0.94-82.7) and 3.1 (0.27-14.3), respectively. Conclusion: The HPLC-FLD method can serve as a cost-effective and reliable analytical method to measure 1OHP and 2NAP (with additional refinement) in an LMIC laboratory and support biomarker activities of the HAPIN trial.

## **P02.3450. Age-Period-Cohort Analysis of Blood Lead in the United States, 1976-2016**

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**Abstract:** Background: Blood lead in the U.S. population has decreased substantially since 1970 owing to exposure reducing measures. Historically the trajectory of blood lead over time has been described in terms of secular-trend in age-specific geometric means. To our knowledge, an alternative analytical approach, age-period-cohort analysis, has not been applied to nationally representative data. Objective: To investigate how age, period, and birth cohort are associated with lead body burden in the U.S. population. Methods: Data on 76,066 individuals, who took part in National Health and Nutrition Examination Surveys (NHANES) conducted in 1976-1980, 1988-1994, and 1999-2016 and were born since 1900, were used. The main outcome was erythrocyte lead. Geometric means by birth decade and 5-year age groups were described graphically. Using log-linear regression, erythrocyte lead was modeled as a function of age, period, and/or birth cohort variables, entered as either discrete or continuous (transformed and/or as natural spline). Results: A descriptive plot of erythrocyte lead over age by birth decade cohort showed that, after the 1976-1980 period with relatively small differences by birth decade and age, erythrocyte lead had a marked decrease, which is consistent with the decrease previously documented in blood lead. Preliminary regression-based analysis revealed that during 1976-1980 erythrocyte lead varied by birth decade and already was decreasing over calendar time at an age-dependent rate. For instance, erythrocyte lead of participants aged 50 in 1976 decreased by 39.4% (95% confidence interval 32.0%-42.8%) 4 years later. Conclusions: The age-period-cohort analysis was useful in visualizing and uncovering certain previously unrecognized patterns in time-related changes in lead body burden. Further analyses are underway, using data from 1988-1994 and 1999-2016, for which a continued decrease in blood lead over time has been documented.

**P02.3460. Environmental Tobacco Smoke Exposure among Children at 7 Years of Age in Japan: Associated Factors and Urinary Cotinine Levels**

Machiko Minatoya

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**Abstract:** Abstract Introduction: Child exposure to environmental tobacco smoking (ETS) remains as a major issue, with adverse health consequences such as obesity, neurobehavioral disorders. This study aimed to identify associations between ETS exposures of children at 7 years of age defined by parent-reports and child urinary cotinine levels and sociodemographic factors. Methods: Child exposure to ETS was assessed by urinary cotinine levels and parent-reported questionnaire in 1440 children in the prospective birth cohort study. The questionnaire included parental smoking habit, and sociodemographic variables. Definition of ETS was if either/both parent(s) smoked or urinary cotinine level > LOQ (1.30 ng/ml). The associations were examined by logistic regression. Results: Based on parent-reports and the urinary cotinine levels, 55.5% and 34.2% of children were exposed to ETS at 7 years of age. Among 492 children with quantifiable urinary cotinine levels, the geometric mean was 6.77 ng/ml (minimum = 1.30 and maximum = 325.5, respectively). Children from younger parents, lower parental education levels, lower annual family income and maternal cotinine levels at 3rd trimester of pregnancy had higher odds ratio (OR)s for ETS and for quantifiable urinary cotinine levels. Past ETS exposure was also associated with increased ORs. Even mothers do not smoke beside children, log<sub>10</sub> transformed urinary cotinine level significantly increased ( $\beta=0.49$ , 95% CI: 0.37, 0.62). Smoking more than 10 cigarettes/day by either of both mothers and fathers significantly increased urinary cotinine levels of children. Conclusions: ETS exposure was confirmed in 34% of children by urinary cotinine measurements, and is still an unresolved public health issue in Japan. Not smoking beside their children was not enough for them to avoid ETS. The health professional should put more emphasis to the parents on the importance of controlling the ETS exposure of their children.

**P02.3470. Decrease in Urinary Biomarkers of Di-2-Ethylhexyl Phthalate (DEHP) Metabolites and Oxidative Stress in Children after Withdrawal from Exposure to 2011 Taiwan's DEHP-Tainted Food Scandal: A 44-Month Follow-Up**

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**Abstract:** Background: A major health scandal involving phthalate-tainted foodstuffs occurred in Taiwan in 2011. The presence of a clear relationship between phthalate toxicity in children and oxidative stress as the main cause is still under question. This study investigated temporal changes of oxidative stress by monitoring two urinary oxidative stress biomarkers: 8-OHdG and MDA with urinary DEHP oxidative metabolites during 44 months following withdrawal of the tainted food. Methods: Two cohorts were established. One cohort was collected from a Phthalates Clinic for Children in southern Taiwan between May 31 and June 17, 2011, in Kaohsiung Medical University Hospital (KMU cohort). That cohort of children was followed up at 2, 6, and 44 months. The other cohort was collected from a nationwide health survey conducted by Taiwan's National Health Research Institutes (NHRI) for people potentially exposed to phthalate-tainted foods post-scandal, between August 2012 and January 2013 (NHRI cohort). The current study only included children 10 years old and younger who had provided enough urine for the final analysis, including urinary DEHP oxidative metabolites, 8-OHdG and MDA concentrations. Results: In the KMU cohort, estimates of DEHP daily intake and the two biomarkers of oxidative stress levels (urinary 8-OHdG and MDA) were found to have decreased to nadir by the follow up at six months. These low points were maintained at follow-up of 44 months and were similar to those found for the NHRI cohort whose urine samples were collected post scandal at 15 to 18 months. Generalized linear mixed models by generalized estimating equation (GEE) in KMU cohort found that levels of predicted values of 8-OHdG and MDA at visit of 2, 6, and 44 months, were significantly lower than at baseline visit ( $p < 0.001$ ). Conclusions: We conclude that oxidative stress can be reversed in children exposed to phthalate-tainted foodstuffs after withdrawal from the sources of exposure till 44-months follow up.

**P02.3480. Associations between Urinary Organophosphorous Flame Retardant Metabolites and Measures of Adiposity in the U.S. General Population: NHANES 2013-2014**

Lesliam Quiros-Alcala

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Abstract: Organophosphorous flame retardants (OPFRs) are synthetic chemicals commonly added to many consumer products, including furniture, electronics, and building materials. Emerging in vitro and in vivo animal studies suggest that OPFRs may alter metabolism and affect obesity risk via effects on sex and thyroid hormones, peroxisome-proliferator-activated receptors, and oxidative stress. In this study, we examined cross-sectional associations between five urinary OPFR metabolites [diphenyl phosphate(DPhP), Bis(1,3-dichloro-2-propyl) phosphate(BDCPP), Bis(2-chloroethyl) phosphate(BCEtP), Dibutyl phosphate(DBuP), and Bis(1-chloro-2-propyl) phosphate(BCPP)] with adiposity measures [obesity, body mass index(BMI) and waist circumference(WC)] among 1351 adults aged 20-80 years and 638 children aged 6-19 years participating in the US National Health and Nutrition Examination Survey. We estimated associations in multivariable logistic and linear regression models, adjusted for age, gender, race/ethnicity, urinary creatinine, smoking, diet, physical activity, and screen time. For adults, we observed increased prevalence odds of being obese vs. normal weight among those with detectable BCPP levels (adjusted Prevalence Odds Ratio (aPOR):1.78,95% Confidence Interval, CI:1.20,2.64) as well as increased prevalence odds of having a high vs. normal WC (aPOR:1.65,CI:1.17,2.32). Among children, we observed a significant inverse association between log<sub>10</sub>-DBuP concentrations and the prevalence odds of being obese vs. normal weight (aPOR:0.41, CI:0.22,0.77). Similar trends were observed with BMI z-scores ( $\beta$ :-0.36,p=0.02) and WC ( $\beta$ :-3.14,p=0.03). Overall, OPFR associations did not differ by gender among adults or children. Findings suggest that exposure to certain OPFRs may be differentially associated with body size among adults and children. Future prospective studies are needed to confirm these findings and take into account potential windows of susceptibility, including the prenatal period.

## **P02.3490. Pb-Adulterated Turmeric: A Growing Problem**

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Abstract: Spice adulteration remains a global public health issue. Evidence indicates that contamination of turmeric with lead (Pb) is a growing problem in the United States and likely other countries. Since 2011, over 20 brands of ground turmeric and curry powder sold in the United States have been recalled due to contamination with Pb. For example, in 2016 approximately 337,000 pounds of curry powder was recalled in Florida and New York due excessive concentrations of Pb. Several international media outlets have cited adulteration of turmeric with Pb chromate, which is vibrant yellow and closely matches the natural color of turmeric, as an ongoing problem. India and Bangladesh are major exporters of the global turmeric supply and in 2010 the Times of India reported over 100 bags of turmeric contaminated with Pb chromate were found at a spice manufacturing plant. Turmeric use is increasing, including as a natural dye in cheeses, cereals, mustards, margarines and packaged foods intended for children, such as Kraft Macaroni and Cheese<sup>®</sup>. Since 2011, multiple childhood Pb poisoning cases attributable to consumption of contaminated turmeric have been reported by Departments of Public Health. Furthermore, turmeric has become popular due to its natural anti-inflammatory properties; it is currently the best-selling dietary supplement in the United States. Turmeric-based beverages are increasingly available at mainstream grocery stores; after dehydrating several of these beverages, we found a 12-ounce juice may contain up to 18 grams of turmeric powder. The FDA has not established a recommended maximum level for Pb in spices and since spices are typically excluded from general U.S. population dietary surveys, accurate estimates of intake are challenging. The evidence suggests turmeric is adulterated with Pb to enhance its weight, color, or both. Researchers and public health officials should be aware of this growing source of dietary Pb exposure.

**P02.3500. Urine Collection Methods for Non-Toilet-Trained Children in Biological Monitoring Studies: Validation of a Disposable Diaper for Characterization of Tebuconazole Exposure**

Paul Scheepers

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Abstract: Young children differ from adults in their exposure and susceptibility to environmental chemicals (e.g. pesticides) because of various factors such as behavior, diet and physiology. Furthermore, children of 0-3 yr. old are rarely included in biomonitoring studies and thus the information on the exposure of chemical compounds of this group is very limited. Their heightened vulnerability to environmental stressors makes it important to obtain appropriate urine samples for exposure characterization. However, collecting urine from non-toilet-trained children has been shown to be methodologically and practically challenging. The aim of this study was to examine and evaluate different urine collection methods for non-toilet-trained children that could be applied in a non-clinical setting. Four urine collection approaches were tested, including a disposable diaper, a urine bag, a collection pad containing a hydroscopic polymer, and the clean catch. The success rate, defined as the percentage of total attempts which were suitable for urine analysis, and the user rating on a 0-10 scale (0=inconvenient, 10=convenient) of each method were evaluated. The success rates were 67%, 21%, 17% and 4% for the disposable diaper, urine bag, collection pad and clean catch, respectively. The average user ratings on a 0-10 scale were 9.0, 4.7, 7.3 and 2.5, respectively. Subsequently, the best rated method, the disposable polyacrylate diaper was tested with hydroxy-tebuconazole as an exposure biomarker for the fungicide tebuconazole and creatinine for urine density adjustment. Recoveries were on average 107% for hydroxy-tebuconazole and 87% for creatinine. Precisions for both analytes were between 3% and 10%. Based on this study, we consider the disposable diaper as a suitable method for urine collection of non-toilet-trained children for biomonitoring of tebuconazole. This study can serve as a basis to extent this method other substances of interest.

## **P02.3510. Cardiovascular Biomarker Validation in Dried Blood Spots and Plasma for the Household Air Pollution Intervention Network Trial**

Savannah Gupton

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Abstract: Dried blood spots (DBS) are a novel matrix for cardiovascular biomarkers and are lower in cost and participant burden than venous blood collection. The objective of this study is to determine if the analysis of whole blood extracted from DBS via finger stick yields comparable biomarker values as the analysis of venous blood plasma. This study was conducted as a series of validation studies for biomarkers of interest in the Household Air Pollution Intervention Network Trial (HAPIN). Finger-stick DBS and venous-drawn blood were collected for the pre-intervention, formative research among 40 women in Rwanda, Peru, and Guatemala (n=120 paired samples). The biomarkers of interest are indicators of cardiovascular distress and inflammation: C-reactive protein (CRP), vascular adhesion molecule-1 (VCAM-1), and intercellular adhesion molecule-1 (ICAM-1). Existing paired samples at Emory University, USA, were used to develop the analytic methods. We used the MESO Scale Diagnostics MESO SQ QuickPlex 20 with MSD Vascular Injury Panels, which include capture antibodies on four spot, 96-well plates. We utilized an incubation and extraction procedure with a PBS Tween 20 0.05% eluate to liquefy the DBS. We will compare biomarker concentrations for the two collection/analytic methods via correlation and Bland-Altman plots. Preliminary results utilizing samples from the methods development indicate high correlation between paired samples for CRP (r=0.98) and moderate to low correlation for ICAM-1 (r=0.28) and VCAM-1 (r=0.17). Our results suggest that DBS may offer reliable measures of inflammation, particularly for CRP. Further analyses will inform the choice of biomarkers for the main trial by incorporating samples as collected, stored, and transported in the variable environments of the HAPIN locations. The use of DBS to measure biomarkers could have important implications for large field studies by including populations where venous blood collection may not be feasible.

## **P02.3520. The Value of Population Cohorts and Biobank Resources to Address Environmental Health Issues: The Cartagene Platform**

Nolwenn Noise!

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**Abstract:** Chronic diseases result from a combination of individual genetic predisposition and exposure to environmental risk factors. The joint assessment of exposure and disease outcome is the key to accelerate breakthroughs in environmental health research. The selection of reliable and unbiased indicators are necessary to carry out high quality research but remains a big challenge. Large population cohorts and biobanks can provide high quality data for the assessment of both exposure and health effects. The CARTaGENE (CaG) cohort is the largest prospective health study in Québec. Since 2007, CaG recruited 43,000 participants, aged 40-69 years at baseline. CaG is characterized by a wealth of collected data on each participant: health questionnaire (lifestyle, mental health, etc.), physical measures (blood pressure, spirometry, electrocardiogram, etc.), food frequency questionnaire, residential and occupational histories, biochemical measures (eg. lipids, glycated hemoglobin, creatinine), and genotyping data. The CaG biobank contains biosamples (blood, plasma, urine, etc.) for more than 30,000 participants. These biosamples allow for the measurements of additional biomarkers (exposure or effect) for specific purposes. CaG databases are linked to administrative health databases which are of great value to inform about health care use and, along with prospective follow-up questionnaires, enable to collect data on a continuous manner to identify temporal variations. CaG is fully integrated in the Canadian Partnership for Tomorrow Project, which represents 300,000 participants and more than 150,000 biological samples available for health research. CaG was created to support the scientific community in identifying the determinants of chronic diseases of environmental and/or genetic origin. Longitudinal population cohort such as CaG offers very powerful tools for environmental epidemiology studies.

## P02. Risk Assessment and Policy 2

### P02.3530. Stochastic Modeling of Exposure to Chemicals in Consumer Products

Olivier Jolliet

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Abstract: Recently, increasing attention has been paid to the near-field human exposure to chemicals in consumer products. To characterize these exposures, we first used the Stochastic Human Exposure and Dose Simulation Model (SHEDS) to generate the number of users and the mean chemical used per user for a simulated US population of 25,000 persons for 9700 chemical-consumer product combinations. We then estimated the product intake fraction - the fraction of chemical taken in - using a modified USEtox model to determine direct transfer fractions and cumulative fraction taken in by various receptors. These direct transfer fractions were calculated for these 9700 product-chemical combinations by 7 underlying models, including skin surface layer, object surface layer, article interior, indoor air, food contact material, pesticide and direct environmental emission. We then multiply the PiF by the chemical mass in products to determine the total intake dose, focusing on 34 chemicals monitored in the National Health and Nutrition Examination Survey (NHANES). The average population dose accounting for both users and non-users intakes ranges from 8.2E-8 to 3.1 mg/kg-d and is dominated by user contributions. The dose received by the users and by the average population can differ by several orders of magnitude. For example, for benzyl butyl phthalate the doses for direct user and average population are 394 and 0.036 mg/kg-d, respectively, indicating that this chemical is only in products used by 0.01% of the population. In contrast, the methylparaben doses for direct user and average population are 13.3 and 3.1 mg/kg-d, respectively, indicating that methylparaben is in products widely used (23%) in the population. For all 34 chemicals, the mean inferred dose from NHANES biomonitoring data ranges from 2.29E-8 to 126 mg/kg-d, similar to our estimated average population doses, the model tending to overestimate doses, pointing at the need to consider chemical prevalence in further studies.

## **P02.3550. Spatiotemporal Augmented Representation of Indoor Air Quality as a Tool for Decision Making**

Nastaran Arfaei

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**Abstract:** A growing body of research points to the effects of indoor air quality (IAQ) on health and cognitive performance. IAQ measurements allow for the evaluation of indoor environments, and new sensor technology has made measurement more accessible. However, effective decision making for improvement of these environments is only possible through an understanding of the spatiotemporal distribution of these elements indoors. We designed an augmented reality (AR) system that takes real time air quality data from multiple sensors and creates a spatial map of these conditions. The program interpolates between the data points and creates a real-time three-dimensional heatmap that represents the concentration of air quality indicators. This map is projected on the physical environment through an AR application. This overlaid map can be seen through a digital device such as android tablet, cell phone or through Microsoft HoloLens (an AR headset). Users can toggle between various environmental factors such as CO<sub>2</sub>, particulate matter, humidity and temperature with the use of a virtual button. This novel system has the ability to make invisible environmental exposures visible through AR, which has implications for building design/operation, space use and occupant behaviors.

## **P02.3570. Effects of High Intensity Local Exposure of a 10 Ghz-Electromagnetic Field on Glial Activity in Rat Brain**

Hiroshi Masuda

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**Abstract:** The possibility of radio-frequency electromagnetic fields (RF-EMF) of mobile phones to cause any adverse health effects on the brain is a subject of numerous studies and publications. Our previous studies have shown that no changes in microcirculatory parameters such as blood-brain barrier and leukocyte behaviors in pial microcirculation were found in the rat brain locally exposed to 1439 MHz EMF even at 2.0 W/kg of brain averaged specific absorption rate (BASAR). On the contrary, several recent studies reported that glial cells activated, indicating inflammation level, after the exposure to RF-EMF under non-thermal exposure conditions. However, the intensity level of RF-EMF exposure, which can occur the activation of glial cells, is still arguable. Therefore, it was necessary to define the intensity of local brain exposure to RF-EMF which affects the activation of glial cells. The aim of the present study was to investigate a threshold of the local exposure intensity of RF-EMF for the glial cells activation. Male Sprague-Dawley rats (8-9 weeks old) were used in this experiment. The rats were anesthetized with isoflurane (inhalation). The head of each animal was fixed in the stereotaxic apparatus and locally exposed to 10 GHz RF-EMF for 18 min using a monopole antenna. The field intensity was adjusted to make 0 to 2207 W/kg of averaged SAR in target tissue area. The two types of glial cells, microglia and astrocyte were observed 24 hours after the exposure using immunohistochemistry. As results, obvious morphological difference between sham-exposed and exposed animals were found in microglial cells. The RF-EMF exposure changed their morphology of ramified phase into those of ameboid phase under the high intensity exposure conditions. In contrast, there was no difference in astrocyte between two exposed groups even the same intensity level. We are now investigating the threshold intensity of RF-EMF for the microglial activity and expect to show it in the meeting.

## **P02.3580. Estimates of Exposure to Chemical Threat Agent Surrogates in the United States, 2012**

Dulaney Wilson

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**Abstract:** The development of effective medical countermeasures against chemical threat agents is a priority. Limited civilian exposure to such agents limits our ability to develop effective countermeasures for humans. We propose to use the unintended exposure to agents similar to chemical threat agents as surrogates in order to describe the estimated national incidence of emergency department (ED) visits and hospitalizations for such agents in the U.S. National incidence estimates for 2012 were derived from the de-identified Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) dataset and the National Emergency Department Sample (NEDS). Visits for exposure to chemical threat agent surrogates were defined using International Classification of Diseases, 9th edition; Clinical Modification (ICD-9-CM) codes for specified (e.g. nitrogen oxides, chlorine, hydrocyanic acid) and unspecified irritant gas exposures as well as unintentional poisoning by organophosphates, fumigants and medicinal bromine. Frequency of visits was described. In 2012, there were ~31 million ED and 7.1 million inpatient (IP) visits in the HCUP data; when weighted these visits reflect 134 million ED and 36 million IP visits in the U.S. The estimated incidences of any toxic gas exposure were 96.7 ED and 75.8 IP per 100,000 visits. With regard to specific exposures, the estimated incidences for unspecified gas exposure were 39.8 ED/43.9 IP; for other specified gas exposure, 32.6 ED/17.6 IP; for nitrogen oxide exposure, 24.1 ED/14.9 IP; for hydrocyanic acid exposure, 5.3 ED/2.6 IP; and for chlorine exposures, 1.3 ED/0.4 IP per 100,000 visits. In general, the ED visit incidence was higher than IP visits with the exception of visits for an unspecified gas exposure although the magnitude differed by specific exposure. The incidence of ED and IP visits for chemical threat surrogates appears to be sufficient to inform prospective comparative studies of medical countermeasures to these threats.

**P02.3590. The Federal Research Action Plan on Recycled Tire Crumb Used on Synthetic Turf Playing Fields and Playgrounds: Tire Crumb Rubber Characterization and Exposure Study Recruitment Strategy and Questionnaire**

Kelsey Benson

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Abstract: The U.S. Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds is a multi-agency collaborative effort with several research activities. CDC/ATSDR and EPA conducted a tire crumb characterization study and a pilot-scale exposure characterization study. The tire crumb characterization study aimed to analyze tire crumb rubber for a variety of chemicals and to characterize field use patterns and maintenance procedures using a structured questionnaire. The objective of the exposure characterization study was to characterize activity patterns for synthetic field users and measure exposure to chemicals during activities at synthetic turf fields. For the tire crumb characterization study, a convenience sampling approach was used for recruitment of potential fields. A total of 306 community field owners/managers were contacted for potential participation, and sample collection was completed at 40 synthetic turf fields, including 21 community fields and 19 military installation fields. A questionnaire was administered to each field/facility owner/manager to gather information about their synthetic turf field facilities, field users, operations, and maintenance. For the exposure characterization study, participant recruitment was conducted at three fields (two outdoor and one indoor) that participated in the tire crumb characterization study. In-person recruitment was conducted Monday through Thursday immediately prior to, during, and after field activities. The study included 32 participants who provided responses about their frequency, duration, and types of activities at athletic fields, as well as information about hygiene, and other potential exposure information. This presentation will describe recruitment strategies and criteria for field selection and field users, field/facility operations and maintenance that could affect potential exposures and questionnaire results from the exposure characterization study.

## **P02.3610. Relative Oral Bioavailability of Cobalt and Nickel in Residential Soil and Dust Affected by Metal Grinding Operations**

Caroline Ring

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**Abstract:** In vivo relative bioavailability (RBA) assessments were conducted for cobalt (Co) and nickel (Ni), in baghouse dust, surface dust, and soil collected in a neighborhood near a metal forge. Baghouse dust contained 8,000 mg/kg Co and 45,000 mg/kg Ni; surface dust contained 970 mg/kg Co and 6000 mg/kg Ni; and soil contained 53 mg/kg Co and 330 mg/kg Ni. Test materials (baghouse dust, surface dust, and soil) and reference materials-cobalt chloride (CoCl<sub>2</sub>) and nickel sulfate (NiSO<sub>4</sub>)-were administered daily for 14 or 21 days, twice daily, to juvenile swine. Daily intake doses for Co were  $\leq 229$  mg/kg-day and for Ni  $\leq 1,419$  mg/kg-day. Concentrations of Co and Ni were measured in liver, kidneys, femur, and duodenum; 24-hour urinary excretion of each metal was also measured. Multiple linear regression modeling was performed for tissue concentration or urinary excretion vs. dose in each material, with weighting as inverse variance in each dose group. RBA for each test material was estimated as the ratio of best-fit slopes for test material and reference material. Models were evaluated on residual heteroscedasticity and goodness-of-fit metrics. Uncertainty in RBA was estimated from uncertainty in the best-fit slopes. Cobalt RBA in baghouse dust was 8.7% (90% CI: 2.6%-15%); in surface dust, 12% (90% CI: 0.47%-23%); and in soil, 3.8% (90% CI: -6.0%-14%). Nickel RBA in baghouse dust was 4.5% (-57% to 53%); in surface dust, 2.4% (90% CI: -9.6% to 14%); and in soil, 20% (90% CI: -78% to 106%). Nickel RBA estimates were highly uncertain in soil and baghouse dust, likely because the soluble reference material (NiSO<sub>4</sub>) was poorly absorbed. These data demonstrate that cobalt and nickel in soil and dust affected by metal alloys are resistant to absorption. This study provides useful information to be incorporated into site-specific human health risk assessments.

## **P02.3620. Emerging Regulatory Issues and Exposure Assessment of Furfuryl Alcohol**

Jamie Schenk

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Abstract: Furfuryl alcohol (FFA) is a flavoring agent used in a variety of consumer food products, including coffee, tea, cocoa, milk products, nuts, breads, popcorn, and cask-stored alcoholic beverages. FFA in food products is typically produced as a byproduct of thermal processing or aging of alcoholic beverages. A National Toxicology Program (NTP) study in 1999 indicated that there may be "some" evidence of carcinogenic activity in male F344/N rats and male B6C3F1 mice through the inhalation route. The ingestion route was not evaluated. As such, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) concluded in 2000 that there is "No safety concern at current levels of intake when used as a flavoring agent." A panel on Food Additives, Flavorings, processing Aids and Materials in Contact with Food also came to the same conclusion. However, the U.S. Environmental Protection Agency (EPA) classified FFA as "likely to be a human carcinogen", followed by California's Office for Environmental Health Hazard Assessment (OEHHA) adding FFA to its Proposition 65 list as a carcinogen. There are several limitations of the NTP study, yet this study serves as the backbone of several regulations. The NTP study did not evaluate ingestion, yet conclusions based on inhalation are being used to inform policy that primarily pertains to ingestion. Additionally, neoplastic changes were only observed at the highest doses, which may have exceeded the maximum tolerated dose. We suggest that a linear extrapolation to estimate exposures at human-relevant doses may not be appropriate for FFA. Therefore, we propose an alternate non-linear model to more accurately estimate low dose exposures, with examples of exposure assessments for certain food products.

## **P02.3650. Fluoride Levels in Mexican Foods and Beverages**

Lynda Luna Villa

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**Abstract:** **INTRODUCTION** The sources of fluoride exposure for the Mexicans are foods, beverages, fluoridated salt and naturally fluoridated water. The main objective of this study was to estimate the concentration of fluoride in foods and beverages most frequently consumed in Mexico; in addition, their fluoride content was compared to data available from the United States (US) and the United Kingdom (UK). **METHODOLOGY** From the Health and Nutrition Survey 2012 we identified 182 foods and beverages and purchased in the biggest supermarkets chains and local markets in Mexico City. Samples were analyzed for fluoride content at least in duplicate to account for variability at the Oral Health Research Institute, Indiana University School of Dentistry, using a modification of the hexamethyldisiloxane microdiffusion method. **RESULTS** We tested 166 foods and 16 beverages, classified into 14 food groups to compare with their US and UK counterparts, and finding among them a very wide range of values. Foods with the lowest and highest fluoride content were vegetable shortening (0.24µg/100g) and fried/baked pork rinds (1465.40µg/100g), respectively. The food groups with lowest and highest content were eggs (2.32µg/100g) and seafood (371.29µg/100g), respectively. When estimating the amount of fluoride ingested per portion size, the lowest values corresponded to eggs and the highest to fast food. When comparing between countries, meats and sausages, cereals, fast food, sweets and cakes, fruits, dairy products, legumes and seafood from Mexico, presented higher fluoride contents than similar foods from the US or the UK. Drinks and eggs from the US exhibited the highest fluoride contents, while this was the case for pasta, soups and vegetables from the UK. **CONCLUSION** The majority of tested Mexican foods and beverages contained higher fluoride contents than their US and UK counterparts. The Mexican data generated in this study will be useful to facilitate the monitoring of the intake in the population.

## **P02.3660. Hexabromocyclododecane Transfer from Flame-Retarded Curtains to Attached Dust**

Takeo Sakurai

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Abstract: Dust is potentially important as a medium of exposure to low- and semi-volatile organic compounds in the indoor environment. To examine the transfer of hexabromocyclododecane (HBCD) isomers to dust on the surface of flame-retarded curtains, a series of 196-day laboratory experiments were conducted using two types of curtains and attached dusts. Concurrently, the physicochemical properties (vapor pressure, water solubility, and octanol-water partition coefficient) of the HBCD isomers were measured because knowledge of the isomer-specific values of these properties is still limited. HBCD isomers migrated from curtains to dust on a timescale of about 20-50 days. The composition of HBCD, dominated by  $\gamma$ -HBCD in the curtains, was dominated by  $\alpha$ -HBCD in the post-experiment dusts, probably because of the higher vapor pressure of  $\alpha$ -HBCD compared to  $\gamma$ -HBCD. The initial HBCD contents of the two curtains were comparable, but the concentrations and profiles of HBCD isomers in the post-experiment dusts differed markedly, probably because differences between the texture, surface finishing of the treated fabrics, or both affected HBCD transfer to the attached dust. We hypothesized that HBCD vapor from the curtain was sorbed onto dust surface and then gradually diffused into the interior of the dust particles, and a mechanistic model based on this hypothesis qualitatively reproduced the observed HBCD concentrations in house dust.

**P02.3670. Identification of Cells Involved in the Induction of TNF- $\alpha$  Expression by Methylmercury in the Mouse Brain and Its Molecular Mechanisms**

Gi-Wook Hwang

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Abstract: Methylmercury is an environmental pollutant that causes neurotoxicity. Recently, we found that tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ; inflammatory cytokine) is selectively induced in the brain of mice administered methylmercury. Although TNF- $\alpha$  may be involved in the neurotoxicity caused by methylmercury, the mechanisms involved in the induction of TNF- $\alpha$  expression by methylmercury are unknown. In this study, we aimed to identify cells involved in the induction of TNF- $\alpha$  expression by methylmercury in mice brain, to elucidate the underlying molecular mechanisms. Seven days after subcutaneous injection of C57BL6 mice with methylmercuric chloride (25 mg/kg), TNF- $\alpha$  mRNA levels were determined in the brain tissues by in situ hybridization. We found that TNF- $\alpha$  was hardly expressed in the saline-administered group, whereas TNF- $\alpha$ -expressing cells were observed in the whole area of the brain in the methylmercury-treated group. It was reported that astrocytes and microglial cells are involved in the induction of TNF- $\alpha$  expression. Therefore, we performed immunostaining using antibodies specific for GFAP or IBA1, which are specifically expressed in astrocytes and microglial cells, respectively. The TNF- $\alpha$ -expressing cells did not overlap with the GFAP-positive cells, but with the IBA1-positive cells. The results suggest that microglial cells are mainly involved in the induction of TNF- $\alpha$  expression by methylmercury in the mouse brain. In addition, methylmercury induced TNF- $\alpha$  expression in mouse microglial cell line BV2. MAP kinases such as JNK, ERK, and p38 are known to be involved in the induction of TNF- $\alpha$  expression in microglial cells. We found that all three MAP kinases were phosphorylated by methylmercury treatment. Moreover, when the cells were pretreated with specific inhibitors, only the p38 inhibitor suppressed the induction of TNF- $\alpha$  expression by methylmercury. These results indicate that methylmercury may induce TNF- $\alpha$  expression via activation of p38 in microglial cells.

## **P02.3680. Mapping Soil Heavy Metal Levels in England and Wales for Application in Public Health**

Annalisa Sheehan

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**Abstract:** Background/Aim: Heavy metals, especially Lead (Pb), Cadmium (Cd) and metalloid Arsenic (As), have known health impacts. Using extensive soil sampling data from the British Geological Survey (BGS) we aimed to generate reliable soil metal concentration surfaces, with accompanying measures of uncertainty, to identify areas exceeding health-based guideline values. Methods: The BGS soil metals data for Pb, Cd and As comprise an amalgamation of six different surveys collected over a 34-year period and have up to four samples per km<sup>2</sup>. Ordinary Kriging (OK) and Empirical Bayesian Kriging (EBK) were applied to an 80% stratified sample (i.e. 80% random sample of each survey, comprising 36,802 'training samples'). The remaining 20% 'test sample' (9,202 samples) was used for cross-validation. The predicted standard error generated via the EBK approach was mapped to quantify the uncertainty/error in the interpolated surface. Results: The OK and EBK interpolation methods generated similar soil concentration surfaces, and cross validation with the held-back test data indicated moderate to good model performance: Spearman's rank correlation coefficients 0.83 (Pb), 0.72 (As) and 0.57 (Cd). Overall, the models tended to underestimate metal concentrations, although at lower levels (where the majority of the samples clustered), the models both over and under-estimated metal concentrations. For each metal, the areas of high uncertainty (i.e. high standard errors) were located in the areas with high soil metal concentrations. In terms of small areas exceeding health based guideline values, almost 4% of Lower Layer Super Output Areas (LSOAs) exceeded the UK soil guideline value for As, and 3.6% exceeded the USA EPA hazard standard for Pb for residential children's play areas. No LSOAs exceeded the UK soil guideline value for Cd. Conclusions: These soil metal concentration surfaces can be used to identify areas exceeding health based guidelines.

**P02.3710. Living and Working Conditions of Children and Adolescents Inserted in the Outsourcing Informal and Household Productive Arrangement of Jewelry and Fashion Jewelry in Brazil**

Kelly Polido Kaneshiro Olympio

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Abstract: Limeira is a Brazilian city, which has an important role in the production of jewelry and fashion jewelry in Latin America. Among the many problems involved in the productive arrangement of jewelry and fashion jewelry, such as chemical exposure and inadequate work conditions, it is the child labor. The work of this vulnerable population means one of the serious and controversial topics in public health in several countries. The aim of this study was to evaluate the living and working conditions of 11-17-year-old students (n=17), involved in the informal and home productive arrangement of jewelry and fashion jewelry, in Limeira. The participants were divided into 2 groups ("work with jewelry at home" and "non workers"). Two questionnaires were applied during school and vacation times: A comprehensive questionnaire on working and living conditions and a time-budget protocol to fill during 10 consecutive days. This latter includes information to be daily registered on potential main activities performed during wake and rest times around the clock (24h). Chi-squared/Fisher and t-student tests were performed to compare time (minutes) of study, sleep, and leisure between the two groups. No significant differences were detected comparing both student groups regarding age and sex. 15 youths were males (88%) and the age mean was 14.9 years. During the school period, working teens showed the lower mean duration of time to study at home (p=0.030), leisure (p<0.001) and sleep (p<0.001) than non-working students. During the vacation period, working students also showed reduced leisure (p<0.001) and sleep times (p<0.001). In summary, this study shows that working at home has a harmful effect on living conditions of this studied population, affecting both study, leisure and sleeping times. These data should be considered as an exposome component to evaluate long-term health endpoints and their possible causes. This study was funded by FAPESP (2016/11087-8; 2017/14392-9) and CNPq.

## **P02.3720. On the Estimation and Use of Dermal Permeability Coefficients**

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Abstract: Two general approaches are most commonly applied to quantitative estimation of dermal absorption of chemicals. The first is fixed fractional or first order absorption. This approach is not generally well grounded in physics, and has obvious limitations, but is simple, convenient and routinely encountered. Dermal absorption can also be more rigorously conceptualized as thermodynamically driven diffusion through a membrane. This permits mathematical representation of the process using Fick's law. In this approach, the key parameter is the permeability coefficient, which is most conventionally estimated as the ratio of flux to driving force, expressed as a concentration gradient, at steady state. The resulting permeability coefficient is vehicle specific. Theoretically such a permeability coefficient should be roughly constant (with allowance for damage, moisture content, interpersonal variation in skin characteristics, etc.) for a given compound, vehicle, temperature and skin location. In practice the standard assumptions required for estimation of permeability coefficients are often violated. Frequently encountered estimation errors include misspecification of the driving force and evaluation of non-steady results using the steady state form of Fick's law. Lack of adherence to theoretically defensible practice has produced unnecessary confusion in the peer-reviewed literature. Current interest in dermal exposure to SVOCs in indoor environments, and to flame retardants in particular, has produced a flurry of recent publications, in multiple journals, in which first order rate constants have been incorrectly described as permeability coefficients. This suggests that lack of familiarity with basic dermal absorption concepts remains an issue within exposure science.

## **P02.3730. The Use and Misuse of Bradford Hill in American Tort Law**

Raymond Neutra

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Abstract: More than fifty years ago, Sir Austin Bradford Hill's Presidential Address to the Royal Society of Medicine-The Environment and Disease: Association or Causation?-identified some examinations that could be conducted upon features of epidemiological data that researchers could undertake to assist inferences about the ability of environmental agents to cause disease. We conducted a Westlaw search of largely federal district and appellate court decisions citing "Hill's aspects," "Hill's considerations," or "Hill's criteria" that identified numerous illustrative instances in which Hill's address has been invoked by judges. We will analyze both incorrect and correct uses of the results of the examinations that Hill proposed. Among the legal misinterpretations of Hill that we have found are: (1) Requiring that all of Hill's recommended examinations be carried out (2) Treating the examinations as criteria with yes/no answers as if they were like Koch's Postulates and with symmetric impact of supportive and un-supportive results (3) Requiring statistical significance of associations in each considered study (4) demanding that Rate Ratios be greater than 2.0 (5) Demanding that the body of evidence include epidemiology (6) demanding that the body of evidence include toxicology. All of these demands are contrary to Hill's recommendations. In addition, we argue that understanding the probabilistic foundations of epidemiology shows that Hill is well justified in his recommended examinations of epidemiological evidence and his recommendations for interpreting the results of those examinations to warrant causal inference. We provide numeric examples to show how many of Hill's examinations are like rule-in/ but not rule-out laboratory examinations and that the prior plausibility of an association, ought, indeed to influence our degree of causal certification. Understanding the probabilistic roots of Hill's recommendations provides a deeper justification for them.

**P02.3740. Non-Linear Model Analysis of the Relationship between Cholinesterase Activities in Rats Exposed to 2, 2-Dichlorovinyl Dimethylphosphate and its Metabolite Concentrations in Urine**

Hiroataka Sato

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**Abstract:** Background and aim 2, 2-dichlorovinyl dimethylphosphate (DDVP) is an organophosphate (OP) widely used for the insect pest control operation and to maintain the household environment. However, there are few reports about the relationship between dimethylphosphate (DMP) excreted into urine as a metabolite and health effect. In the present study, the non-linear model analysis was performed to estimate the threshold of DMP corresponding to the cholinesterase inhibition. Methods A total of 40 male Wistar rats (11-week-old) was divided into four groups and orally administered DDVP (control, 0.2, 1.0 and 5.0 mg/kg/day) for two weeks (five-day treatment per week). The blood, brain and urine were collected after the final administration. The cholinesterase (ChE) activities of the brain, red blood cell (RBC) and plasma were analyzed by Ellman method (Voss G et al, 1970). DMP was examined by using gas chromatography-mass spectrometry. Statistical analyses and model estimation were conducted with drc package (version 3.0-1; Ritz C et al, 2015) for R (version 3.4.1). Results Each of the ChE activities in the 5.0 mg/kg/day group was significantly inhibited when compared with the control group (Steel-Dwass method,  $p < 0.05$ ). The relationships between ChE activity and total urinary DMP excretion were represented as dose-response curves by three non-linear models for brain and RBC ChE and one model for plasma ChE. The estimated DMP corresponding to 20% inhibition of ChE was 0.34 mg/24h for brain and 0.11 mg/24h for RBC, which were calculated by averaging the results of three models, and 0.23 mg/24h for plasma. Their lower limits of 95% confidence intervals were 0.04, 0.06 and 0.09 mg/24h, respectively. Discussion and conclusion In this study, the non-linear model analysis, i.e. Benchmark Dose (BMD) analysis (Crump et al, 1984), was used to estimate the reference value of DMP derived from DDVP. The estimated concentration could be used to assess the human health risk of DDVP exposure.

## **P02.3750. Cumulative Risk Assessment Based on Human Biomonitoring Data for Three Anti-Androgenic Phthalates Using the Maximum Cumulative Ratio in Iranian Children**

Maryam Zare Jeddi

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**Abstract:** The aims of this study were to estimate the profile, exposure and daily intake of five different phthalates, and to assess the health risks of the cumulative exposure to anti-androgenic phthalates in Iranian children. In the assessment of phthalate exposure, concentrations of three anti-androgenic phthalates including dibutyl phthalate (DBP), butyl benzyl phthalate (BBP), and diethylhexyl phthalate (DEHP) were analyzed in the spot urine sample of 56 Iranian school children aged 6-18 years. In this study, the hazard index (HI) approach is applied to estimate cumulative exposure to three anti-androgenic phthalates. Furthermore, the Maximum Cumulative Ratio (MCR) is used to quantify the degree to which a single chemical drives the cumulative risk of an individual exposed to multiple chemicals. Results: The range of the estimated daily intake was 0.01 µg/kg body weight/day for BBP and 17.85 for DEHP µg/kg body weight/day. However, the result of cumulative risk assessment suggested that the combine exposures to anti-androgenic phthalates were of relatively low concern (HI values in the surveyed participants averaged 0.2). The range of MCR value in the 56 participants was 1.1 to 2.32. The cumulative exposures of concern mainly originated from two of the three anti-androgenic phthalates including DBP and DEHP. Conclusions: Although the hazard index values for all anti-androgenic phthalates were below 1, the detection of all phthalates metabolites in 92.9% of samples population indicates that children are exposed to mixture of phthalates simultaneously. In addition, aside the investigations of phthalates in this regard, take into account that children are exposed to numerous other chemicals with anti-androgenic properties which may also contribute to a cumulative anti-androgenic effect.

## **P02.3770. Emerging Compounds in Standard Reference Material 2585 Organic Contaminants in House Dust**

Jessica Reiner

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Abstract: Standard Reference Materials (SRMs) are homogeneous, well-characterized materials that are used to validate measurements and improve the quality of analytical data ([www.nist.gov/srm](http://www.nist.gov/srm)). Originally issued in 2005, SRM 2585 Organic Contaminants in House Dust was intended for use in evaluating analytical methods for legacy organic pollutants (including polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and chlorinated pesticides) in house dust and similar matrices. This SRM, while intended for analysis of legacy compounds, became an important matrix for the measurement of emerging organic chemicals (polybrominated diphenyl ethers, synthetic musks, per- and polyfluorinated compounds (PFAS), and newer use flame retardants) because interlaboratory studies of these compounds showed considerable disagreements. NIST has been measuring these emerging chemicals in SRM 2585 with the goal of assigning values on the Certificate of Analysis. In late 2017 NIST finished measurements and updated SRM 2585 with the addition of polycyclic musks, PFAS, and selected flame retardants. This presentation will highlight the methods for adding analytes to an existing SRM and provide values for emerging compounds in SRM 2585.

## **P02.3780. Data Quality Evaluation for Epidemiologic Studies Under Amended TSCA**

Francesca Branch

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Abstract: The amended Toxic Substances Control Act (TSCA) requires EPA to conduct chemical risk evaluations to determine whether chemicals present an unreasonable risk to human health and the environment. Any science-based decisions must "use scientific information, technical procedures, measures, methods, protocols, methodologies, or models, employed in a manner consistent with the best available science." To meet these requirements, EPA systematically searched and identified data for 10 existing chemicals that are currently undergoing risk evaluation. Multiple streams of data (engineering, environmental release, exposure, fate, ecological health and human health) were screened for relevancy using eligibility criteria. EPA then developed criteria to assess the methodological quality of the relevant studies, and to determine the extent to which these studies are reliable and unbiased. This presentation will describe the evaluation tool that EPA designed to review epidemiologic data on exposure and health. Epidemiologic studies can contain information both on chemical exposure and human health hazards, and as such will be assessed independently to support the exposure and hazard assessments. EPA used elements of evaluation procedures implemented in past TSCA risk assessments, and adapted/supplemented with elements from other established evaluation tools (e.g., IRIS, OHAT, Money, Lakind) in order to design epidemiologic evaluation criteria that are fit for purpose and fulfill the scientific standards requirements under amended TSCA. The views expressed in this abstract are those of the authors and do not represent Agency policy or endorsement.

## **P02.3790. Spatial Analysis of Environmental Inequalities with Biomonitoring Data: A Cumulative Risk Assessment**

Florent Occelli

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**Abstract:** Differential and not fair exposure to environmental risk factors across socio-demographic groups, called environmental justice (EJ), may contribute to inequalities in health and most often put disadvantaged groups at higher risk for environmental health effects. Main literature has difficulties to consider the potential exposure of populations to different levels of air pollutants. Cumulative and long-term exposures are still seldom considered. We propose a comprehensive EJ methodology to prioritize and characterize neighborhoods which takes into account the cumulative impact of health determinants. For this purpose, the use of environmental biomonitoring is an innovative approach to consider the integrated and long-term exposure to complex air pollution. Cumulative Impact Screening (CIS) methodology was used for two contrasted living areas of France. CIS is based on synthetic and composite index construction. Three scores were attributed to each neighborhood according to a cumulative calculation of key parameters: environmental score (using 3 air biomonitoring parameters: trace elements loads in lichens, lichenic biodiversity and dust deposition on poplar leaves), socioeconomic deprivation score and susceptible population score. Each score can be considered as a dimension of health vulnerability. CIS analysis and maps highlighted the unequal spatial distribution of EJ. After the multi-criteria hierarchization of spatial units, the influence of each dimension was characterized in each neighborhood with radar charts. We demonstrated that environmental biomonitoring is a smart approach to fill the lack of available data on multiple air pollution at the local scale. The tool developed is specific to the territory and transposable, which facilitate adoption by a variety of community and stakeholders and prioritization of public health actions. Correlations between EJ and health data are currently assessed to explain the spatial heterogeneity of chronic disease incidence.

## **P02.3800. Research, Communication, and Policy Change: PFAS in Food Contact Materials**

Tom Bruton

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**Abstract:** Introduction: Poly- and perfluoroalkyl substances (PFAS) are used to provide water- and oil-repellency in consumer products, including food packaging. Some PFAS are persistent and toxic, and can migrate from food contact materials into food. However, there is limited data on PFAS occurrence in food contact materials. This presentation will describe research performed using a novel screening technique to measure the fluorine content of a variety of food contact materials, as a proxy for the presence of PFAS. The presentation will also explain the communications strategy used to publicize the results, as well as policy developments that it helped to prompt. **Methods:** Food packaging and disposable food service ware were collected from U.S. grocery stores, fast food chains, and institutional purchasers. Samples were analyzed for fluorine content using particle-induced gamma-ray emission (PIGE) spectroscopy. A subset of samples was tested for individual PFAS using liquid chromatography/high resolution mass spectrometry (LC/HRMS). Results were publicized using a joint press release strategy and a workshop attended by diverse stakeholders. **Results:** Approximately one third of fast food packaging tested contained fluorine levels indicative of intentionally added PFAS. The LC/HRMS analysis confirmed that the detection of fluorine was associated with the presence of PFAS. These results received widespread media attention. At the same time, purchasers began asking their suppliers of food contact materials about PFAS in their products, prompting some suppliers to reevaluate their manufacturing processes. Legislation restricting the use of PFAS in food contact materials has since been introduced in several states and was recently signed into law in Washington State. **Conclusion:** Targeted research combined with an effective communication strategy can motivate decision makers to reduce the use of potentially harmful chemicals in commercial products.

## **P02.3830. Evaluation of Potential Health Risk of Non-Intentionally Added Substance (NIAS) Food Contact Material**

Deborah Lander

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Abstract: Background International Life Sciences Institute (ILSI) recently published a guidance for conducting exposure and risk assessment for non-intentionally added substances (NIAS). With the publication of this guidance, there is increased activity in the food packaging industry to study NIAS and confirmation of safety of food contact materials. The ILSI approach was evaluated using a case study of 2-ethyl-acrolein (EA) as a NIAS in polymeric food contact material (FCM). Methods A risk assessment was performed using the ILSI approach combined with the threshold of toxicological concern approach, a read across to acrolein in which toxicity data based on animal testing and human health risk assessment benchmarks are available. The oral exposure is estimated based on the amount of food in contact with a normalised area of the food contact material, and the release/migration of EA into the food from the material. A risk characterisation ratio (RCR) was estimated based on ingestion route of exposure. Results EA was identified as a possible mutagen based on in-vitro tests but there is very little in-vivo testing. Acrolein also tested positive in in-vitro mutagenicity testing but cancer was not detected in whole animal studies for the oral exposure route. Both substances are unsaturated aldehydes and a read across from EA to acrolein is proposed. The RCRs based on conservative exposure estimates of EA content <42 ppm in the FCM <1 (an indication of no increase in health risk) for both toddlers and adults. Discussion Read-across is one of the most commonly used alternative approaches for data gap filling in global regulatory environments and can reduce the need to generate toxicity data for trace level compounds present in food contact materials as NIAS. The current content levels of EA as NIAS do not indicate an increase in health risk.

**P02.3850. Idiopathic Environmental Intolerance Attributed to Electromagnetic Fields in Magnetic Resonance Imaging Examinees**

Chang-Chih Tsai

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**Abstract:** Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) is defined as a set of symptoms perceived by individuals when they are exposed to electromagnetic fields (EMF). The EMF from magnetic resonance imaging (MRI) scanners are the strongest that the general population may encounter. We conducted a study on the symptoms experienced by MRI examinees to identify associated factors. We recruited participants who were between 20 to 79 years of age at a medical center in Taiwan. The MRI facility was a Philip Achieva 1.5T MRI scanner. All participants were volunteers among examinees who were arranged to receive MRI examinations. We used a standard questionnaire to collect data on demographic characteristics and symptoms before the MRI examination. A questionnaire of the same symptoms was administered again immediately after the MRI examination. We excluded candidates who were arranged to receive a brain MRI or who had history of brain lesions, seizures, psychiatric problems, or claustrophobia. We recruited 200 candidates, and they all completed the questionnaires. We excluded 9 who reported having diplopia, which is not a typical symptom of IEI-EMF and thus was used to identify over-reporting. Of the 191 participants included in the analyses, 37 (19.4%) had symptoms during the MRI examination that were not perceived before the examination ( $p < 0.001$  for the Mc'Nemar test). The five most common symptoms which appeared only after the MRI examination were dizziness, ear discomfort, anxiety, palpitation, and poor attention. Of the 10 participants with self-reported IEI-EMF (5.2%), 9 reported symptoms after the MRI examination, with an odds ratio of 22.92 (95% confidence interval: 2.83-185.7,  $P < 0.001$ ). Further studies are needed to clarify whether the symptoms are caused by the EMF produced by the MRI scanner.

**P02.3860. Concentrations of Pharmaceuticals and Endocrine Disruption Effects in Water Extract Samples in a Concentrated Animal Feeding Operation of Korea**

Kyunghee Ji

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Abstract: Concentrated animal feeding operations (CAFOs) have been suggested to be one of the significant sources of pharmaceutical residues in the environment. However, limited information is available on the potential risks of major pharmaceutical residues in the aquatic environment near CAFO areas. In the present study, 10 veterinary antibiotics, including sulfonamides, tetracyclines, and cephalosporins, along with three analgesics (acetaminophen, ibuprofen, and mefenamic acid) were measured in water samples collected from the streams that run near a CAFO in Korea. The potential toxic effects of the water extracts on steroidogenesis were evaluated using human adreno-carcinoma (H295R) cell lines. The pharmaceuticals were detected at higher levels in the samples collected downstream of the CAFO than in those collected upstream. Levels of the target pharmaceuticals were lower in the samples collected during the high-flow season than in those collected in the low-flow season. In terms of steroidogenic potential, greater production of 17 $\beta$ -estradiol (E2) was observed in the samples collected near the CAFO than in those collected further away, suggesting that pharmaceuticals from CAFOs may possess endocrine-disrupting toxicity. The increase in E2 production is well supported by significant up-regulation of the aromatase (CYP19A1) gene, which catalyzes the final step in the conversion of androgen to estrogen. Our observations show that the aquatic environment near CAFOs could be heavily contaminated with veterinary pharmaceuticals and analgesics, which could induce endocrine disruption.

## **P02.3880. Quantifying Impacts of Emission Reductions on Air Pollution Equity and Health Effects in New York City**

Amir Hakami

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**Abstract:** This study examines inequity in exposure to fine particulate matter (PM<sub>2.5</sub>) in New York City and surrounding areas across income groups. By contrasting the sensitivities of public health and equity measures to emissions reductions on a location-by-location basis, this study offers novel yet practical suggestions to coordinate air quality management strategies that prioritize different policy endpoints. Air quality simulations were run using the USEPA's Community Multiscale Air Quality (CMAQ) model and its adjoint version over New York City at 1 km resolution. CMAQ is used to estimate concentration surfaces for quantifying exposure to PM<sub>2.5</sub>. Second, the adjoint of CMAQ was run to estimate the sensitivity of domain-wide inequity parameters to pollution emissions, on a location-by-location basis for different sectors. Preliminary results show that lower income populations in New York City tend to be exposed to higher concentrations of PM<sub>2.5</sub>. We find that emission reductions in Brooklyn, Harlem, and the Bronx would be most beneficial for reducing domain-wide inequity, while reductions in Manhattan would result in increased inequity. We also calculate monetized health benefits per ton of primary PM emissions across the domain, with benefits estimated to be significant (as high as \$10M/ton) and spatially variable across the domain. We propose a novel approach for monetizing air pollution inequity, and find that monetized benefits from inequity reductions are comparable in magnitude (up to \$5M/ton) to health benefits from avoided mortality. We examine hypothetical scenarios where quantified benefits with regards to health an inequity are considered in tandem to coordinate policies that target both endpoints simultaneously. Our results demonstrate that focusing emission reductions on sources that are influential on both environmental justice and public health can yield improvements across multiple policy goals simultaneously.

**P02.3910. Careful - Causal Reasoning for Human Health in Experimental Toxicology and Epidemiology: A Joint Case Study on PFOA**

Rob Jongeneel

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Abstract: The project CAREFUL examines the underlying cultures, issues and reasons behind interactions between toxicologists and epidemiologists. The final aim is to arrive at improvement of the process and content of joint risk assessments and at a better message to stakeholders. Phase 1 of the project will develop a common understanding of the argumentation and the weight-of-evidence elements used in both disciplines and the way inferences about the likelihood of causality are made (Lebret et al., this conference). The joint case study on PFOA will be used to develop and adjust a common framework, also taking into account the toxicological (still rather novel) concepts of Mode of Action (MoA) and Adverse Outcome Pathways of chemicals to etiological understanding of pathophysiology and disease development in humans based on (molecular) epidemiology. The case study of PFOA and other cases will also be used to determine the implications of the new approach for risk communication by practitioners of risk assessment, regulators and other stakeholders. This presentation will show the results of the PFOA case study.

## **P02.3920. The Class Concept: Better Policy and Purchasing for Organohalogenes**

Arlene Blum

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"Abstract: INTRODUCTION: Most of the 80,000 chemicals in use today have not been adequately tested for toxicity. Chemicals in certain chemical classes, such as families of organohalogenes, have similarities in structure and/or function and also have the potential to cause similar harm. Grouping such substances into classes can lead to a more integrated understanding of their functions, uses, and potential for harm, thus allowing for management actions around entire classes of similar chemicals. It also can prevent the common problem of "regrettable substitution," where a phased out chemical is replaced with a series of closely related "chemical cousins" that lack adequate fate and toxicological data and cause similar harm. METHODS: The class concept was developed during a series of Toxics Reduction Retreats where government, academia, business, and nonprofits came together to develop innovative solutions to reduce the use of chemicals of concern. RESULTS: The "Six Classes" concept identifies six families of substances containing a large proportion of the harmful chemicals commonly found in consumer products. They are: (1) highly fluorinated chemicals, (2) antimicrobials, (3) flame retardants, (4) bisphenols and phthalates, (5) some solvents, and (6) certain metals. CONCLUSIONS: The chemical class concept is a simple framework for reducing the use of harmful substances. It can motivate targeted research and communication around the properties of each class which can contribute to more informed decision making by regulatory agencies, manufacturers and large purchasers. Before using or approving a chemical from one of the "Six Classes," specifiers, purchasers and regulators can ask if the chemical's function is essential. If the function is indeed necessary, they should seek safer chemical or design alternatives. Thus, the class concept can motivate effective action to reduce use of and exposure to harmful chemicals, contributing protecting to human and ecosystem health. "

## **P02.3930. Strategic Communication of Exposure Science and Environmental Epidemiology**

Virginia Guidry

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**Abstract:** Background: Complex environmental health problems require multidisciplinary solutions and public support. Exposure scientists and environmental epidemiologists can use a range of tools to expand the reach of their work and help translate research findings into informed decisions. We will describe how to manage an online presence, including social media profiles, with a professional lens. Objective: Engaging with traditional media and social media can be daunting, so we will share guidance and concrete examples of how to be effective practitioners. Discussion: Traditional media is still a key source of public information. Effective media interviews require understanding what journalists need, including a timely response and clear, plain language explanations. Describing your science in a non-technical way can be challenging and takes preparation. Social media must be used strategically to maintain high quality and value. We will share examples of message development, for research and related purposes, across social media platforms like Facebook and Twitter. LinkedIn, the premier networking tool, helps to form connections and expose your career to potential employers and collaborators. ResearchGate and Academia provide ways to share manuscripts, presentations, posters, and other communication formats. Such online tools can keep the work alive for much longer than the limited conference presentation time, with a broader audience. We will review environmental health-related examples from active practitioners, common pitfalls, and recommendations for best practices with these platforms. Conclusions: Strategic engagement between scientists and public stakeholders can increase the power and efficiency of science. Engaging in traditional and social media can facilitate the formation and growth of partnerships, increase public awareness of environmental health topics, and inform decisions that can help address environmental health issues on local and global scales.

## **P02.3940. Active Machine Learning in Systematic Literature Reviews: Bias, Fixes, and Appropriate Use**

Cara Henning

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Abstract: Text analytics has emerged as a cost-effective innovation used to support systematic literature reviews in human health risk assessments. Text analytics approaches allow some studies to be removed from consideration without undergoing manual review. Supervised machine learning relies on a training dataset to build models that go on to automatically classify a larger set of unclassified documents. However, manually reviewing references to create the training dataset can be resource intensive. "Active" machine learning is a potential solution that uses an algorithm to focus on the most informative documents, reducing the number of references that must be manually reviewed. We simulate active machine learning by using a set of approximately 7,000 abstracts from the scientific literature that was previously classified by subject matter experts with regard to relevance to epidemiology. We examine the performance of alternative sampling approaches to sequentially expanding the training dataset, specifically looking at uncertainty-based sampling and probability-based sampling. We discover that while such active learning methods can potentially reduce training dataset size compared to random sampling, active machine learning-based predictions of model performance potentially suffer from bias that negates its potential benefits. We discuss approaches and the extent to which the bias resulting from skewed sampling can be compensated. We compare the results from active machine learning to those based on a semi-supervised machine learning method called supervised clustering and show how the latter, with only a small training dataset, can outperform the former in terms of (i) accuracy of model predictions and (ii) the fraction of documents eliminated from review. Finally, we propose a useful role for active learning in contexts where accuracy metrics are not critical and/or where it is necessary to rapidly retrieve a subset of relevant literature.

## **P02.3950. High Dimension Biological Analysis of Carbon Nanotube Toxicity**

Spyros Karakitsios

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**Abstract:** The toxic effects of multi-walled carbon nanotubes (MWCNTs) are associated with intracellular oxidative processes related to generation of reactive oxygen species (ROS). This is enhanced by metallic impurities that can be mobilized from the carbon nanotubes to the surrounding biological microenvironment. Aiming at identifying the effects of exposure to purified and unpurified MWCNTs on different biological targets immunological, biochemical, gene expression and biological pathway analyses were carried out on samples from healthy humans and in vitro models. The MWCNTs with higher amount of metallic impurities caused a 1.8-fold increase in lipid hydroperoxide levels, while the number of mature T lymphocytes with reduced potential underwent a more than 3-fold increase, as compared to the purified MWCNTs. Whole genome transcriptomics in lung epithelium cells (A549) and keratinocytes (HaCaT) showed that gene expression is significantly modulated after exposure to purified and unpurified MWCNTs. 48-hour exposure resulted in approximately 500 genes expressed differentially in the case of MWCNTs with different levels of impurities. Similar results were found when we analyzed the data isolating the 25 genes involved in the molecular pathway associated to oxidative stress. The persistence of the induction of genes driving chemokine and cytokine-signaling-mediated inflammation showed the importance of the inflammatory effects of MWCNTs, and in particular the unpurified ones. Pathway analysis showed significant modulation of genes related to the NFkB pathway, after exposure to unpurified MWCNTs, as a result of oxidative stress induction. This may cause a perturbation of the IL-6 pathway that aims to regulate inflammatory processes and compensate apoptotic changes. Overall observed immunological responses related to MWCNT exposure are considered the result of the synergistic effect of systemic (mediated by cells of the exposure routes) and local inflammation (blood cells).

## **P02.3960. Multi-Criteria Assessment of Household Preferences for Reducing Greenhouse Gas Emissions: An Analysis of Household Survey Data from Four European Cities**

Paul Wilkinson

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**Abstract:** Objective To assess household preferences for reducing greenhouse gas (GHG) emissions with respect to criteria of CO<sub>2</sub>e emissions, health impact and cost. Setting Mid-size cities in France, Germany, Norway and Sweden (the HOPE project). Method An inventory of 65 GHG reduction actions was assessed using a CO<sub>2</sub>e emissions, health impact and cost calculator for 309 households. The impact of each action on health was graded using a five-point scale (slightly negative, no impact, and three grades of health benefit). Each action was then compared in terms of these three dimensions (CO<sub>2</sub>e reduction, cost, health) using scores which gave alternative priority weightings to each dimension. The results were examined in relation to the proportion of respondents declaring their willingness to implement each action. Results Actions rated most highly on the combined CO<sub>2</sub>e reduction-health-cost score included switching towards an increasingly vegetarian diet, reducing motor vehicle use in favour of public transport and/or walking and cycling, giving up ready meals, and measures to improve insulation of the home (roof, walls, windows). However, most households were unwilling to make substantial shifts towards becoming vegetarian or towards reducing motor vehicle use. Actions that respondents were often willing to implement and scored highly on the three dimensions of impact included: eating 30% more vegetarian food, walking and cycling instead of using public transport, 'eco-driving', and improvements of roof and window insulation. Conclusion Most householders appear willing to make appreciable changes to their lifestyle and home in order to help achieve GHG emissions reductions, including (but not limited to) moderate (not extreme) dietary modification, some reduction in private vehicle journeys, and home energy efficiency improvements. Though such actions may alone not be sufficient to meet pressing GHG reduction targets.

## **P02.3970. Stakeholder Engagement for Decision-Making on Urban Air Pollution Control**

Nelzair Vianna

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**Abstract:** Air pollution has been a major problem in cities around the world and a challenge for public health in the 21st century. The local scientific evidence is crucial to decision-making and urban planning. Risk analysis methodology is based on an intersectoral and interdisciplinary approach that promotes stakeholder engagement. Few studies have focused on a discussion of newly developed tools that facilitate dialog between scientists, civil society, and urban planners. **Objective:** To discuss tools capable of engaging stakeholders and providing scientific evidence to support policies on urban air pollution control and urban planning in Salvador, Bahia-Brazil. **Methodology:** Researchers presented scientific evidence to local government officials regarding the results of a local study evaluating the replacement of the city bus fleet and its influence on air quality. Considering the initiatives proposed by the Paris agreement, Salvador joined an international alliance of cities that agreed to fight climate change. The dialogue between scientists and decision-makers has promoted efforts to combat climate change in partnership with C40 (Compact of Mayors) to provide scientific evidence on health, environmental, economic and social impacts. Data collection involved local stakeholders. **Results:** Our risk analysis approach promoted dialogue among the local stakeholders, highlighting the relevance of implementing policies, the need to improve public transport and the energy matrix. The improvement in indicators demonstrates that local actions are crucial in fighting climate change. Civil society involvement was stimulated by risk communication through local media and presentations in the community. Risk management includes planning improvements in public transportation and promoting new urban green spaces. **Conclusion:** We showed that involving stakeholders in different phases of scientific research facilitates the dialogue necessary for decision-making.

## **P02.4000. Evaluation of the Applicability and Reliability of Environmental Exposure Models for Nanomaterials to Regulatory Risk Assessment**

Natasha Chander

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Abstract: Environment and Climate Change Canada is required to perform science-based risk assessments under the Canadian Environmental Protection Act (CEPA). The risk assessment process takes into consideration both the hazardous properties and environmental exposure of a substance. Canada has gathered significant experience in the risk assessment of chemical substances through the Chemicals Management Plan (CMP). However, the risk assessment of nanomaterials poses some challenges, including uncertainty regarding nanomaterial lifecycle and environmental fate. Consequently, the use of environmental exposure models would be of particular interest to characterize the fate and behaviour of nanomaterials in the environment, and to estimate Predicted Environmental Concentrations (PECs). This poster presents a review of the available environmental exposure models and tools specific to nanomaterials. It will discuss the relevance of these models in the Canadian regulatory context, and will consider their reliability with respect to predicting the fate and presence of nanomaterials in the environment.

## **P02.4010. Case Studies of Human Integrated Risk Assessment for Phthalates and PFCs in Korea**

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Abstract: Recently, in Korea, human integrated risk assessment and management (HIRAM) program of chemicals in consumer product and food has launched by Korean FDA. The HIRAM program tried to integrate two different data sources for risk assessment; the external and internal exposure assessment both in personal level and population level. First of all, both external media monitoring and biomonitoring data in personal level were conducted to analyze the knowledge and data gap for HIRAM and to suggest refined assessment strategy. The refined aggregate exposure assessment has been applied to the general population and find out who and how many is population at risk. Finally, the refined aggregate risk assessment was compared with biomonitoring data for general population independently conducted by Korean EPA, and FDA. Case studies for DEHP and PFCs were conducted to compare aggregate exposure with internal exposure estimated from biomonitoring data using toxicokinetic models. In the case of DEHP with fast kinetics, aggregate exposure assessment in personal level confirmed 45% of internal exposure. DBP showed only 15% of the coverage of external exposure to the internal exposure. Person exposure assessment for phthalates did not cover direct exposure scenarios from consumer products. In the case of PFOA/PFOS, 75% and 25% of internal exposure was explained by external exposure. PFOS (half-life: 6.3 years) showed lower coverage than PFOA (half-life: 2.3 years). Most of exposure PFOA/PFOS were from food ingestion. The lower ratio of external and internal exposure would come from the relative high contribution of past exposure due to slow kinetics. Personal monitoring needs to be conducted to cover indirect and direct exposure scenarios of consumer product. Age-structured toxicokinetic models are needed to refine the reverse dosimetry for chemical with slow kinetics.

**P02.4020. Vulnerable Populations and Personal Care Products: The Role of Estimating Exposure to Products Used Primarily by Infants and Young Children**

Sandra Kuchta

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Abstract: Infants and young children are often key sub-populations of interest when assessing exposure to chemicals for human health risk assessments. As developing humans, children have distinct behavioral characteristics and potential routes of exposure that contribute to the unique differences in their susceptibility to environmental exposures. These include, but are not limited to, increased time on the floor, dust ingestion and mouthing of objects. In addition, there are many products that are marketed for use specifically by infants and children, for example diaper cream and baby wipes. No regulatory guidance specific to cosmetics and personal care products with a focus on infants and young children is currently available. This poster will discuss the unique considerations that go into estimating exposures to products used primarily on/by infants and young children. An overview of exposure factors compiled over the last 15 years, as well as the challenges and uncertainties associated with these approaches to risk assessment will be discussed. A few case studies will also be presented highlighting the use of these considerations to quantify chemical exposure in this subpopulation for regulatory risk assessment. These case studies will include substance groupings under the Government of Canada's Chemicals Management Plan such as phthalates, as well as other select substances.

## **P02.4030. Canadian Specific Exposure Factors for Certain Personal Care Products**

Leona MacKinnon

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Abstract: Humans use a variety of personal care products (PCPs) every day. Estimating human exposures to chemicals found in PCPs requires information on the frequency of use and amount of product used. This type of information is usually obtained from various questionnaires and surveys and is available from regulatory guidance documents and in the scientific literature; however, very little data exists for the Canadian population. The Canadian Health Measures Survey (CHMS), a national survey that collects important health information from individuals aged 3 to 79 years old, included some questions regarding the use of certain grooming products by Canadians in Cycle 1 (2007-2009) and Cycle 2 (2009-2011), which sheds some light on Canadian use patterns. This poster will highlight Canadian specific data on the frequency of use of certain PCPs by adults, teens and children as young as 3 years old. The poster will also illustrate how this data is being used by the Existing Substances Risk Assessment Bureau (ESRAB) for risk assessments conducted under Canada's Chemicals Management Plan. Results will be presented on how the use of certain PCPs by Canadians compares with use pattern data from the US and Europe.

## **P02.4040. Health and Security in a Global Digital Transforming Society: Risks and Opportunities**

Yuri Bruinen de Bruin

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Abstract: Thanks to knowledge produced during Human Genomics and Exposome projects, we now know approximately 70% of all human diseases can be explained by 'exposure-throughout-life'. Exposure Science and its combination of ICT and Omics will support the further understanding of the patterns of diseases and will open up even more possibilities, like personalised medicine, not just for treatment but also probabilistic prevention as a function of environmental parameters. Combining these three areas will offer risk managers to take measures that protect the general population, specific groups and individuals and will eventually offer means to repair alternated DNA in the future reorienting the healthcare systems away from costly 'one-size-fits-all' approach. New technologies such as internal and external biomonitoring sensors produce huge amount of data causing an ever further digitalization of health data boosting preventive and curative health care options. Sensors in combination with the release of specific dosages for medical treatments accessible via the internet require high demands on secure data collection, storage, handling and ownership. Like many of the big technological developments outcomes can be used for the good but also for the bad supporting the development of secure health-related information preventing unwanted CBRNE-type (Chemical, Biological, Radiological, Nuclear, and Explosives) incidents. In many countries new streams of health data are generated. These data are important building blocks for a new approach to health research and delivery, tailored to the protective needs the population. Therefore, linking security with health in the digital transformation of the current society is of utmost importance. This presentation will address the opportunities and threats in the frame of security and health in a global digital transforming society and aims to interact with exposure practitioners to develop best practices in field of secure health information.

## **P02.4050. Nitrogen Dioxide: From Science to Policy**

Ninon Lyrette

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Abstract: The Canadian Ambient Air Quality Standards (CAAQS) are a key element of the Air Quality Management System, a collaborative approach implemented by federal, provincial and territorial governments for improving air quality in Canada. This presentation will outline the considerations from the science and the process leading to the development of the CAAQS for nitrogen dioxide (NO<sub>2</sub>). Health Canada's 2016 human health risk assessment for NO<sub>2</sub> is a comprehensive review of the most relevant science. This assessment provides clear evidence of health risks of NO<sub>2</sub> to Canadians and forms the primary scientific foundation for the development of the CAAQS. While NO<sub>2</sub> contributes to the formation of ozone and fine particulate matter, the CAAQS are based on clear evidence linking NO<sub>2</sub> exposure to health effects on the respiratory system. There is also evidence related to effects on the cardiovascular system, on fetal growth and birth weight, and premature death. Epidemiological studies indicate that there is an almost linear relation between short- and long-term exposure to ambient NO<sub>2</sub> concentrations and adverse effects on human health, with no apparent threshold. Given this, any incremental reduction in ambient NO<sub>2</sub> concentrations will directly lead to reduced risks for serious health effects on Canadians for which a large segment of the population is susceptible. Based on these findings, it was concluded that both short-term and long-term standards were needed to protect against these health effects. The health evidence, in combination with other factors such as the environmental effects and the current and projected NO<sub>2</sub> levels, were taken into consideration in the CAAQS development through the Canadian Council of Ministers of the Environment (CCME) mediated multi-stakeholder process. The NO<sub>2</sub> CAAQS, which are specifically targeted at reducing population exposure, were endorsed by the CCME in November 2017, and issued in the Canada Gazette in December 2017.

## **P02.4060. A General Framework to Deal with Uncertainty in Expert Panel Risk Assessment**

Sandrine Fraize-Frontier

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**Abstract:** The importance of clarifying and disclosing uncertainties in risk assessment (RA) has been acknowledged for several decades. However, even today, these uncertainties do not receive the attention they deserve to well inform decision makers. To overcome this situation, diverse regulators, health and safety agencies, and other bodies involving in RA at national, European or international level have recently mobilized themselves by reasserting the need to integrate uncertainty analysis in the RA process and making practical recommendations. The French agency for food, environmental and occupational health and safety (Anses) is one of them. This work presents the general framework developed by the Anses Expert Working Group on Methodology in Risk Assessment. Two critical points were addressed: A typology of uncertainties and a homogenized approach to deal with uncertainty analysis in different areas (human health related to the environment, work and food, animal health and welfare, and plant health). The proposed typology is divided into four classes (Context, Corpus of knowledge, Assessment methodology and Communication), according to the logic of an expert appraisal process. A five-step iterative approach, systematically preceded by a stage for planning the assessment, was proposed as a generic approach of uncertainty analysis. Especially, the importance of considering the decision-making context of the assessment from the planning stage is stressed. The iterative approach was developed to be flexible enough to enable the assessors ensure the analysis is proportionate to and fit for purpose of the assessment. As part of a testing stage, the general framework was applied to different case studies dealing with diverse areas (health RA in humans, animals and plants). This testing phase was carried out in collaboration with different expert panels. It concluded that the generic and flexible nature of the proposed framework should be able to harmonize the practices in RA.

## **P02.4070. Reviews in Environmental Health: How Systematic are they?**

Juleen Lam

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**Abstract:** Background: Systematic review methodologies are gaining traction in the environmental health field, with aims to inform research and evidence-based decision-making. How the methods and results of a systematic review compare to those of a traditional expert-based narrative review on the same topic has not been empirically evaluated. Methods: We identified reviews through the literature searches conducted during 3 Navigation Guide systematic review case studies: (1) Air Pollution and Autism Spectrum Disorder; (2) PBDEs and IQ/ADHD; and Formaldehyde and Asthma. We compared each review to the 9 domains of the Literature Review Appraisal Toolkit (LRAT), a structured appraisal of the methodological strengths and weaknesses of a review. We evaluated each review to determine if it was a self-identified systematic review, and compared the review conclusions to determine if they were broadly consistent with the conclusion of the Navigation Guide case study. Results: We identified a total of 30 reviews eligible for the LRAT appraisal. All non-systematic reviews fell short of all LRAT domains except for "directness of evidence." Among self-described systematic reviews implementation of all of the features of robust systematic review methods was highly variable. Roughly half of all the reviews arrived at conclusions that were broadly consistent with the Navigation Guide systematic review method case study conclusions on the same topic. Conclusions: Systematic reviews are not all equal in quality and result in more transparent and reproducible results than the non-systematic reviews on the same topic. The lack of consistently applying robust methods to synthesize the available data identified in this small study may be prevalent in the field as these methods are new to environmental health. Environmental health scientists should be trained in improved methods for evidence integration and work closely with information specialists in conducting reviews.

## P02. Occupational Issues 2

### **P02.4080. Network on the Coordination and Harmonisation of European Occupational Cohorts (OMEGA-NET)**

Michelle Turner

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Abstract: OMEGA-NET is a 4-year COST Action, starting in October 2017, funded by EU. Paid employment is an essential component of adult life and a major determinant of health and healthy ageing. However, in recent years there has been limited coordination and promotion of European health research on occupation and employment as causes of health problems and inequalities. Europe currently has some of the most valuable occupational, industrial, and population cohorts worldwide. The lack of integration of these cohorts hampers the optimal exploitation of these resources, essential to underpin evidence-based interventions and policy. The overarching concept of OMEGA-NET is to create a network to optimize the use of occupational, industrial, and population cohorts. OMEGA-NET will advance i) collaboration of existing cohorts, with extensive contemporary information on employment and occupational exposures, ii) coordination and harmonisation of occupational exposure assessment efforts, and iii) facilitation of an integrated research strategy for occupational health in Europe. We will inventory numerous cohorts with occupational information in Europe; implement an online interactive tool with detailed information on existing cohorts; facilitate work on harmonisation of occupational exposure and health outcome information and new protocols for data collection; connect scientific communities on occupational health in Europe and beyond. Collaboration through OMEGA-NET will enhance the scientific output from individual studies and facilitate pooled studies, data sharing, and transfer of tools and skills to make greater and more efficient use of existing cohorts. The work will provide a foundation for an enhanced evidence base for the identification of health risks and gains related to occupation and employment to foster preventive strategies and policies. Researchers from countries outside Europe can participate in COST Actions on the basis of ascertained mutual benefit.

## **P02.4090. Multicomponent Monitoring for Safety Management of Greasepaints**

Wanseo Kim

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**Abstract:** Background/Aim Greasepaints are usually used by actors to make up. In recent years, such as films, musicals and Halloween. Demand for Greasepaint is increasing as people enjoy cultural activities such as movies, performances and Halloween. However, due to the use of Greasepaints, people are exposed to harmful substances such as heavy metals and preservatives and so on. In Korea, greasepaints are managed by Ministry of Food and Drug Safety. In this study, we investigated the current status of the management of 6 preservatives, 6 parabens, 5 heavy metals, formaldehyde, 1,4-dioxane, methanol, and phthalate for the safe use of greasepaints. We purchased 95 greasepaints (water 55, oil 40) in Korea and monitored them. We check the actual condition of ingredient marking and check whether the use regulation is well maintained. Methods We pretreated greasepaints in the manner prescribed in Guidelines for Method of Ingredient Analysis for Banned Ingredients in Cosmetics designed by Ministry of Food and Drug Safety. We analyzed using HPLC-DAD(6 preservatives, formaldehyde), UPLC-MS/MS(6 parabens), GC-FID(methanol), GC-MS(3 phthalates), HS-GC-MS(1,4-dioxane), ICP-MS(4 heavy metals), Mercury analyzer. Results Detection rate was as follows; mercury 7.4%, lead 51.6%, antimony 62.1%, cadmium 28.4%, arsenic 31.6%, benzyl alcohol 1.1%, phenoxy ethanol 49.5%, sorbic acid 5.3%, benzoic acid 17.9%, dehydroacetic acid 5.3%, salicylic acid 4.2%, methyl paraben 15.8%, ethyl paraben 4.2%, propyl paraben 8.4%, butyl paraben 13.7%, isopropyl paraben 1.1%, formaldehyde 4.2%, 1,4-dioxane 17.9%, methanol 98.9% and phthalates 1.1-2.1% respectively. Conclusions In this study, blending limit of greasepaints sold in Korea is well maintained. This study is meaningful that it provides quantitative information on greasepaints and provides baseline data for the safety management of greasepaints by providing actual information on ingredient marking.

**P02.4120. Breast Cancer Risk by Occupation in Females and Males in Ontario, Canada: Results from the Occupational Disease Surveillance System (ODSS), 1983-2016**

Jeavana Sritharan

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**Abstract:** Background: While breast cancer is one of the most commonly diagnosed cancers among women, it accounts for fewer than 1% of cancer cases in men worldwide. Few prior studies have been able to study breast cancer in working men. This study uses data from the recently established Occupational Disease Surveillance System (ODSS) to examine risk of breast cancer in both women and men across different occupation groups. Methods: The ODSS was established through the linkage of existing administrative data and contains information on 2,190,246 Ontario workers (1983-2016). Workers were followed up for breast cancer diagnosis in the Ontario Cancer Registry (OCR). Cox-proportional hazard models were used to calculate age-adjusted hazard ratios (HR) and 95% confidence intervals (CI). Results: A total of 17,865 and 492 breast cancer cases were identified in working women and men, respectively. Across both sexes, statistically significant ( $p < 0.05$ ) elevated risks were observed in management (w: HR 1.57, 95% CI 1.42-1.73; m: HR 2.41, 95% CI 1.24-4.66), administrative and clerical (w: HR 1.16, 95% CI 1.11-1.21; m: HR 1.56, 95% CI 1.13-2.13), and teaching occupations (w: HR 1.49, 95% CI 1.41-1.59; m: HR 2.82, 95% CI 1.40-5.66). Other statistically significant elevated risks were observed in social sciences, nursing and other health, transport and equipment operating, and sales commodity occupations for both sexes. Conclusions: Similar findings were found in women and men that warrant further investigation into job-related factors, such as sedentary behaviour, stress, shift work, and for some occupations, radiation exposure. The findings from this study, if validated in other study samples, may help focus breast cancer prevention and education efforts for both females and males.

## **P02.4140. Occupational Noise Exposure is Associated with Hypertension in China: Results from Project ELEFANT**

Hyang-Min Byun

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**Abstract: Background/Aims:** Noise pollution is the second-leading environmental cause of health issues, including increased blood pressure (BP) and cardiovascular disease. Our study sought to examine the association between occupational noise exposure with risk of hypertension and BP by hypertension stage in young Chinese adults. **Methods:** We utilized data from 124,286 young adults (aged 18-40) within Project ELEFANT, a multi-cohort study based in Tianjin, China. Questionnaire data was used to identify high levels of occupational noise exposure, and BP measured by automated device (mmHg). Hypertension stage was diagnosed according to the 2017 High Blood Pressure Clinical Practice Guidelines. We applied adjusted logistic regression models to identify associations with hypertension risk, and examined interactions with BMI, gender and residence in separate models. **Results:** Occupational noise exposure was associated with an increase of 0.23 mmHg in BP (95% CI: 0.10-0.38,  $p=0.0009$ ) among participants with elevated BP, 0.15 mmHg (0.06-0.22,  $p=0.0008$ ) in those with Stage 1 hypertension and 0.41 mmHg (0.27-0.55) with Stage 2 hypertension. The noise exposure-BMI interaction was positively associated with an increase of 0.71 mmHg (0.44-0.99,  $p<0.0001$ ) in elevated blood pressure, 0.78 mmHg (0.60-0.96,  $p<0.0001$ ) in Stage 1 hypertension and 2.06 mmHg (1.73-2.38,  $p<0.0001$ ) in Stage 2 hypertension. Further, noise exposure was associated with a higher risk for Stage 1 (odds ratio: 1.67, 1.47-1.86) and Stage 2 hypertension (1.35, 1.35-2.05) in males than females. Finally, noise exposure-urban interaction was associated with an increase of 0.32 mmHg (0.17-0.48,  $p<0.0001$ ) in elevated blood pressure and 0.44 mmHg (0.27-0.59) in Stage 2 hypertension. **Conclusions:** Occupational noise exposure is associated with increased blood pressure in young adults with elevated blood pressure and Stage 1 & Stage 2 hypertension. Furthermore, noise exposure displays interaction with BMI, gender and residence.

**P02.4150. The Role of School Environments and Occupational Stressors for Michigan Public School Teachers: An Assessment of Stress and Health**

Geila Rajae

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**Abstract:** School teachers experience tremendous occupational stress, which can lead to low retention, missed work days, and lower quality of life. Teachers working in low-resource school districts face unique challenges and stressors, with some experiencing poor indoor air quality, crowding, and biological exposures. The objective of this pilot research was to assess cumulative stressors in low and high-resource public school districts, and the influence these stressors have on perceived stress and biological stress response for teachers. Teachers were recruited from four low- and high-resource school districts in southeast Michigan. Participants were surveyed on demographics, occupation, health, and perceived stressors. Blood pressure and heart rate were measured at the time of the survey. Individual salivary cortisol samples were collected in the afternoon (n=3) and evening (n=3) following the survey. An environmental survey of each teacher's classroom and school was conducted to assess room and school conditions, noise, and proximity to major roadways and industry. Fifty-nine (n=59) teachers were recruited from 26 public schools. Teachers at low-resource school districts had higher afternoon cortisol levels (4.12 nmol/L) and a higher prevalence of hypertension (54%), although not significant, compared to high-resource school district teachers (3.11 nmol/L and 45%, respectively). Low-resource school district teachers had significantly higher reported occupational stress ( $p=0.004$ ); specifically concerning environmental quality, relationships, and demands; and were more likely to feel stressed "very often" and "fairly often" (82%) compared to high-resource school district teachers (45%). Teachers' classrooms and schools were less likely to be classified as well-maintained in low-resource school districts. This research will support priority-setting for reducing occupational and environmental stressors for school districts to improve teacher health outcomes and retention.

**P02.4170. The Influence of Vitamin D Receptor, Metallothionein 1A and 2A Gene Polymorphisms on the Lead Toxicity to the Sensory Nervous System in the Chronic Lead- Exposed Workers**

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**Abstract:** Background and objective: Lead had neurotoxicity in peripheral sensory systems. Variant vitamin D receptor (VDR) genes and polymorphisms of Metallothioneins (MTs) were associated to lead toxicity. But rare relationship between lead neurotoxicity and polymorphisms were discussed before. This study investigated the relationship among the polymorphisms of the VDR, MT1A, MT2A and lead toxicity to sensory nervous system in chronic lead-exposed workers. Methods: We measured 181 workers' vibration perception thresholds (VPT) and current perception thresholds (CPT) as neurological outcomes. The outcome variables were then correlated to the subject's index of long-term lead exposure that was calculated by the subject's serial blood lead data in a period of working duration. The polymorphisms of VDR (Bsm rs1544410, Apa rs7975232, and Taq rs731236), MT1A (rs11640851 and rs8052394) and MT2A (rs10636 and rs28366003) were defined. The potential confounders, including age, gender, body height, smoking, alcohol consumption and working history, were also collected and analyzed in multiple regressions. Results: MT2A rs28366003(AG/AA) and MT1A rs8052394 (GG/AA) had significant different in all frequency of hand and foot CPT/hand and foot CPT 2000Hz, and had the negative regression coefficients. MT1A rs11640851 (AA/CC) had significant difference in all neurological outcomes except hand and foot VPT. In MT2A rs10636, more C allele showed more influence in all three frequency of hand CPT comparing CC with GC and GG. Among VDR, Apa rs7975232 (CC/AA) had most difference in all three frequency of hand CPT, and Taq rs731236(TC/TT) had difference in hand VPT. Conclusion: Individuals with AG genotype for MT2A rs28366003 and GG genotype for MT1A rs8052394 had neural protective effects. On the other hand, CC genotype for Apa (rs7975232) of VDR, CC genotype for MT2A rs10636 and AA genotype for MT1A rs11640851 had susceptibilities to neurotoxicity.

## **P02.4190. Exposure to Metal Fume Particulate Matter and Receptor for Advanced Glycation End Products in Shipyard Welders**

Min-Chien Lo

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Abstract: Inhalation of metal-rich PM<sub>2.5</sub> produces reactive oxygen species (ROS) in the body, which may cause Maillard reactions, produce advanced glycation end products (AGEs). The interaction between the receptor of AGEs (RAGE) and its ligand AGEs triggers the inflammatory signal transduction, elevating risk of chronic diseases including diabetes mellitus. This study was assess the association between exposure to metal fume fine particle matter and production of AGE and RAGE. This study conducted in cross-sectional design and consisted of 52 welding workers and 29 office workers. The exposure assessment was performed for all individuals with a personal sampler to measure eight working hours exposure to metal-rich PM<sub>2.5</sub> on Monday. On Tuesday morning, participants were instructed to fast for at least 10 hours prior to urine and blood sampling. Urinary metals were measured by ICP-MS. AGE and RAGE product was analyzed by ELISA and Flow Cytometry respectively. Multivariable linear regression model was used to assess association between urinary metals concentration and AGE and RAGE expression. PM<sub>2.5</sub> exposure concentrations were 379.93±4.71 µg/m<sup>3</sup> and 154.47±3.56 µg/m<sup>3</sup> in welders and administrative personnel, respectively. RAGE expressions were 1500.78±1743.56 a. u. and 741.05± 537.03 a. u. in welders and administrative personnel, respectively. However, AGE did not significantly differ between these two groups. There was no significant correlation between PM<sub>2.5</sub> and AGE or RAGE. After adjusted for confounders, urinary chromium concentration ( $\beta=0.242$ , 95%CI 0.024-0.339, P=0.025) and urinary cadmium concentration ( $\beta=0.333$ , 95%CI 0.017-0.165, P=0.017) were significantly associated with RAGE expression. However, no significant effect of urinary metals concentration on AGE was found. Exposure to metal fume particulate matter in welders were significantly associated with increasing RAGE expression. Inflammatory response of increased RAGE expression of welders should be further investigated.

## **P02.4200. Quantification of Trisaminohexyl Isocyanurate (TAHI) as a Biomarker of HDI Isocyanurate Exposure in the Plasma and Urine of Automotive Spray Painters**

Leena Nylander-French

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Abstract: Biological monitoring of occupational exposure to 1,6-hexamethylene diisocyanate (HDI)-containing spray-paints is limited to analysis of metabolites of HDI monomer although polymeric HDI isocyanurate constitutes the predominant inhalation and skin exposures for workers in the automotive paint industry. In order to investigate HDI isocyanurate and HDI monomer exposure-biomarker associations, we developed a novel method to quantify trisaminohexyl isocyanurate (TAHI) as a biomarker of HDI isocyanurate exposure in biological samples collected from occupationally exposed spray-painters. Plasma and urine samples were acid hydrolyzed, extracted with dichloromethane, and derivatized with acetic anhydride prior to analysis of the derivatized product, trisacetamidohexyl isocyanurate (TAAHI), with nanoflow ultra-performance liquid chromatography coupled to nano-electrospray ionization tandem mass spectrometry (nano-UPLC-ESI-MS/MS). Analytical and internal standards required for analysis were not available commercially and, subsequently, were synthesized in-house. The calibration curves and method detection limits (MDL) were sensitive and specific for spiked control plasma (N = 11; 0.03 - 3.99 µg/L; r = 1.000; MDL = 0.02 µg/L) and spiked control urine (N = 13; 0.06 - 7.98 µg/L; r = 0.998; MDL = 0.03 µg/L). TAHI was detected in 23 of 112 plasma samples (13 of 46 workers) with an arithmetic mean ± standard deviation of 0.014 ± 0.042 µg/L, and in 130 of 417 urines samples (36 of 48 workers) with an arithmetic mean ± standard deviation of 0.204 ± 0.705 µg/L. The quantification of TAHI as a biomarker of HDI isocyanurate exposure is essential for future research on the pharmacokinetics of uptake and elimination in order to determine the relative potency and dose-relationships between HDI monomer and oligomer exposure.

## **P02.4210. Exposure to Metal Fume Particulate Matter and NO in Exhaled Breath in Shipyard Welders**

Kuan-Yu Shen

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Abstract: Exposure to metal fume particulate matter has been linked to numerous adverse health endpoints. Clinical researches have been clarifying the relation of Fractional nitric oxide (FeNO) with airway inflammation in asthma. Despite this, limited data examining the relation of metal fume particulate matter exposure and NO in exhaled breath in welders. We conducted a cross-sectional study. Study participants consisted of 52 welders and 29 office workers. Exposure assessment was based on eight-hour measurement with a personal PM2.5 sampler of exposure to metal fume fine particle matter on Monday. On Tuesday morning, participants were instructed to fast for at least 10 hours prior to urine sampling. The concentration of NO in exhaled breath, an indicator of acute bronchial inflammation and oxidative stress, was measured first, using the portable analyzer. Then a portable spirometer was used to perform the forced expiratory measurements. PM2.5 exposure concentrations were  $379.9 \pm 4.7 \mu\text{g}/\text{m}^3$  and  $154.5 \pm 3.6 \mu\text{g}/\text{m}^3$  in welders and office workers, respectively. Welders had lower levels of NO in exhaled breath than that of office workers after adjusting for confounds, though the difference was not significant. Participants with current smoking habit had significant lower NO levels compared to non-smokers. Individual urinary metal such as Mn, Co, Ni, and Fe was associated with NO in exhaled breath in all workers after adjusting for confounds. However, only individual urinary Ni, or Fe metal was associated with NO in exhaled breath in welders. No association between any lung function indicators and NO level in exhaled breath was found. We concluded that some particular metals from metal fume particulate matter exposure may be associated with decreasing NO level in exhaled breath in welders.

**P02.4220. Chemical Exposure Related to Occupational Environment of Woven Fabric Workers, Northern of Thailand**

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Abstract: Woven fabric is the famous products in Northern part of Thailand. According to the process of woven product, workers used several chemical along processing which can be contaminate in community environment. This study was conducted using a qualitative study with the aim to determine chemical exposure related to occupational environment of woven fabric workers in Northern part of Thailand. An in-depth interview was completed by face to face from workers in woven fabric with natural dye community during 2017. There were all of members in natural dye community getting involved in this study. The results shown that participant age between 50-70 years. Most of the participants were female. The process of woven fabric product included 1) cotton fibres cleaning, 2) weave cotton fabric and 3) fabric dye. Workers reported that they use detergent in cotton fibres cleaning. For fabric process, workers reported that zinc mordant and natural ash mordant have used in this process, also used chemical and natural materials. All of participants never treat their waste water from the fabric processing before pour. These are activating factors associated with environment problems, especially chemical contaminant in working environment and community environment. The finding suggested that the risk factors of chemical exposure related to occupational environment among woven fabric workers should be investigate. Furthermore, the improvement of working environment and educational related to working activities should be conducted in this community.

## **P02.4250. Reduction in County Population Rates of Sinonasal Cancer Following Improvements in Industrial Hygiene at a Nickel Refinery**

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**Abstract:** Background The Cancer Registry of Norway has virtually complete national data on incident cancers through more than 60 years. In 1973, the Registry published the first study of respiratory cancer among workers at a nickel refinery in Kristiansand, in the county of Vest-Agder. Very high risks had already been found in nickel workers elsewhere (Wales, UK; Ontario, Canada). The Kristiansand refiners had an overall sinonasal cancer rate 28 times the expected, and lung cancer 4.8 times in excess of national background rates. Sinonasal cancer is a rare disease with population rates less than 10<sup>-5</sup> in men (world standard), but the rate in surrounding Vest-Agder county was more than doubled (1953-1971). Later improvements in the refinery process and industrial hygiene have been described. We have found suggestions of a downward trend in respiratory cancer among the refiners. Methods For this ecological study, we used population data for Vest-Agder and national age-specific rates in men to derive locally expected numbers of sinonasal cancer for six decades (1955-2014). The refinery's health care unit contributed the numbers of sinonasal cancer in workers with local residence. Results Before 1995, sinonasal cancers among present or former employees fully accounted for the excess at the county population level. For the last two decades, county numbers were in line with those expected from the national rates (0.8 and 0.7 of expected). Conclusion Lower nickel concentrations and respiratory protection appear to have eliminated the excess of sinonasal cancer, although low background rates may have left a remaining low to moderate risk undetected. Population mobility may also dilute local rates. Potential conflicts of interest: No funding was received for the study. TKG is employed by the Cancer Registry, a governmental institution. SRB is employed by the nickel refinery's health care unit, required by Norwegian law to act as a free and independent advisor in work environment questions.

## **P02.4260. Carcinogenicity of Styrene**

Nadia Vilahur

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Abstract: Styrene is a high production volume chemical primarily used to produce polystyrene polymers and it is found in workplace air in the reinforced plastics industry. Styrene is also present in tobacco smoke, and in air pollution. In March 2018, a Working Group of leading scientists from 24 countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to re-evaluate the carcinogenicity of styrene (in addition to styrene-7,8-oxide and quinolone, not addressed here), based on published human, animal and mechanistic data. The most informative epidemiological studies were occupational cohort studies conducted in different countries in the reinforced plastics industry, suggesting that exposure to styrene causes lymphohaematopoietic malignancies, with higher consistency in the evidence for leukaemias and in particular myeloid leukaemia. However, confounding by other co-occurring occupational exposures such as butadiene, or the presence of biases or chance due to, for example, small sample sizes could not be ruled out. Evidence in humans for other cancer sites, including lung cancer, was sparse or inconsistent. Inhalation studies in rodents showed increased risk for different types of tumours in both sexes. A large body of mechanistic evidence showed that styrene is rapidly absorbed, distributed and metabolized in humans, potentially leading to genotoxic effects in exposed humans and it can modulate receptor-mediated effects and cell proliferation in various human cell lines and animal models. The conclusion of this evaluation of styrene regarding its carcinogenicity in humans is currently under embargo due to publication in the Lancet Oncology, but results will be presented in full at the time of the ISEE meeting.

## **P02.4270. Depression and Related Risk Factors among High Tech Workers in Southern Taiwan**

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**Abstract:** Introduction: Depression, which might lead to the acculmulation of stress and in turn lead to various physical and mental illnesses, has become an important issue among workers in the high-tech industry. In recent years, there were many reports on the work stress associated with depression, but few were from Taiwan. Therefore, we conducted a study to evaluate the associations between depression and burnout among high tech workers. Methods: We recruited workers working in a scientific park in southern Taiwan between Janurary 1 and December 31, 2016. Information on demographic characteristics was collected through a self-administrated questionnaire. Participants also completed Taiwanese Depression Scale (TDS), Chinese Job Content Questionnaire (C-JCQ), and reported habits of smoking and drinking. Results: There were 865 workers participated in this study. We observed positive associations between depression and supervisor, perceived stress, economic stress, work stress and social support (all with  $p < 0.05$ ). After adjusting for other factors, we found perceived stress (adjusted odds ratio [AOR] =3.42, 95% confidence interval [CI]: 2.03-5.76), supervisor (AOR=5.30, 95% CI=1.25-22.43), passive work stress (AOR=3.21, 95% CI=1.69-6.09), and high work stress (AOR=4.83, 95% CI=2.11-11.07), were independent risk factors of depression. Conclusion: Among the high tech workers, depression is associated with perceived stress, management and work stress. Therefore, intervention strategies for depression should take into consideration these factors.

Wednesday August 29

P03. Weather, Climate and Disasters 3

**P03.0010. The Association between Thermal Comfort and Sleep Patterns: Preliminary Results from the Center for Research on Environmental and Social Stressors in Housing across the Life Course (CRESSH) Sleep Sub-Study**

Dayna Johnson

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Abstract: Thermally comfortable sleep environments are necessary for optimal sleep. Vulnerable populations (e.g. racial/ethnic minorities, lower socioeconomic status) are disproportionately affected by adverse housing conditions, which likely impact thermal comfort and sleep. We investigated the influence of thermal comfort on objective and subjective sleep patterns among a racially/ethnically diverse population. Between 2016-2017, participants (N=44) of the CRESSH Sleep Sub-Study underwent 7-day actigraphy for objective measures of sleep duration and sleep efficiency. During a home visit, participants self-reported thermal comfort as "too cold" or "too hot" to fall or stay asleep as well as subjective sleep duration and quality. We conducted chi-square tests to determine whether thermal comfort was related to a short sleep duration (<7 hours), poor sleep efficiency (<90%), or subjective restless sleep. Participants were predominately female (63.6%), minority (38.6% Hispanic, 11.4% Black, 15.9% Asian), college-educated (56.8%), and married (40.9%). The average age was 53.6 years (standard deviation: 16.3). Approximately 47.7% of the sample had a short sleep duration and a poor sleep efficiency and 52.3% reported restless sleep. Most of the sample (56.8%) reported being "too hot to fall or stay asleep" at least once per week; whereas 45.4% reported being "too cold to fall or stay asleep". Participants who reported "too hot" compared to those who did not, were more likely to have restless sleep (56% vs. 26%, P=0.05) and a poor sleep efficiency (68% vs. 42%, P=0.09). "Too hot" was not associated with sleep duration and "too cold" was not associated with the explored sleep measures. Among our racially/ethnically diverse population, poor sleep was common and uncomfortable temperatures were reported barriers to initiating or maintaining sleep. Being "too hot" was related to poor sleep quality, thus thermal comfort may be a point of intervention to improve sleep in this population.

### **P03.0020. Future Wildfires and Air Pollution-Related Health Damages**

Henry Roman

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**Abstract:** Climate change is expected to increase wildfire frequency and intensity around the globe. Examples of these impacts can already be observed in the recent historical record, and as the effects of climate change continue to intensify over the coming century, several studies predict a continuation of this trend. A recent modeling study demonstrated that global area burned may increase by approximately 8% by 2050 and 30% by 2100. This increase has the potential to nullify anticipated declines in anthropogenic sources of fine particulate matter (PM<sub>2.5</sub>), as wildfires become more dominant sources of PM<sub>2.5</sub> around the globe. We use these model simulations of wildfire area burned from the present day to 2100 to generate the first quantitative estimates of the magnitude and economic value of air pollution-related health impacts worldwide associated with future fire activity. We analyze projected PM<sub>2.5</sub> for two alternative scenarios considering both climatic and socio-economic drivers of fire activity, where climatic changes are characterized by representative concentration pathways (RCPs) and socio-economic drivers by shared socio-economic pathways (SSPs). We apply the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) and the 2015 Integrated Exposure Response (IER) Function from the Global Burden of Disease study to quantify the global health impacts associated with fire-related emissions for the present day and future under the two scenarios at a resolution of 0.1 degree x 0.1 degree worldwide. Results presented include the health burden from wildfire PM<sub>2.5</sub> globally, by world region, and by country, for the present day, 2050 and 2090 under two scenarios of climate change and socioeconomic development.

**P03.0030. The Climate and Health Impacts of Achieving National Target Levels of Liquefied Petroleum Gas (LPG) Adoption in Cameroon: Findings from Policy Modelling According to the Cameroon National LPG Masterplan**

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**Abstract:** Introduction As part of its commitments to becoming an emerging economy by 2035, the Cameroon Government has set a target that by 2030, 58% of the population will be using Liquefied Petroleum Gas (LPG) as a cooking fuel, compared to less than 20% in 2014. The aims of this study were to estimate the potential impacts of this planned LPG expansion (Masterplan) on population health and climate change mitigation. Methods We developed mathematical models to measure the health and climate impacts of expanding LPG adoption for household cooking in Cameroon over two periods: 1. Short-term (2017-2030); Comparing Master Plan with a counterfactual LPG adoption of 32% in 2030, in line with current trends. 2. Long-term (2031-2100, climate modelling only); Assuming Cameroon will become a mature and saturated LPG market by 2100 (73% adoption, based on Latin American countries). We compared this with a counterfactual adoption of 41% by 2100, in line with current trends. Results By 2030, successful implementation of the masterplan was estimated to save about 23,000 lives and avert 760,000 disability-adjusted-life-years compared to naturally increasing trends in LPG adoption. For the same period reductions in component emissions of more than a third were found, leading to an annual cooling effect of -4.4 Mt CO<sub>2</sub>-equivalent (calculated with 50% renewable biomass), by applying the Global Warming Potential with a 100-year time horizon, and a global cooling of -0.1 milli °C in 2030. For 2100, a cooling impact for the Masterplan leading to LPG saturation (73%) was estimated to be -0.70 milli °C assuming 90% renewable biomass, increasing to -0.93 milli °C with 50% renewable biomass. Conclusion Meeting the government target of 58% of the population using LPG through successful implementation of the Masterplan will have significant positive impacts on population health and on climate, through reductions of emissions influencing climate and associated global cooling.

### **P03.0040. Regional Variations in Future Temperature-Attributable Mortality**

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Abstract: Regional projection studies for future temperature-attributable mortality due to climate change have been actively conducted for decades. Recently, these projection studies tried to estimate the future mortality more accurately by considering not only climate change but also population change and adaptation. However, these regional projection studies are heterogeneous in various aspects of their study designs. On the other hand, there are a few studies which examined the climate-change-induced health effects on global scale. However, these global-scale studies only compared the regional effects of climate change without detailed analysis as to why they vary. As a result, we still have poor understanding on the sources of the regional variations in climate-change-induced mortality. Qualitatively speaking, the regional mortality variations are the results of regional temperature increase and vulnerability. The temperature increases are known to vary from region to region depending on the various factors. The temperature vulnerability varies depending on factors such as population composition and medical level. It is important to deeply understand the key factors and their impacts on future temperature-attributable mortality. This study estimated the future temperature-related mortality in many locations worldwide. The temperature-mortality relationships were estimated using DLNM, and the effect of climate changes on future temperature-related mortality were predicted under RCP scenarios. Then, we examined the contributions of various factors on the regional variations in the mortality. In this analysis, we introduced a new normalized metric which shows the effect of climate change with respect to 100 ppm increase in global CO<sub>2</sub> concentrations. This study is important to relate the future mortality and 100 ppm increase in CO<sub>2</sub> concentration, thereby providing guidance for setting a carbon budget. Also, this study shows key factors in regional mortality variations.

### **P03.0050. Awareness, Risk Perception, and Protective Behaviors for Extreme Heat and Climate Change in New York City**

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Abstract: Preventing heat-related illness and death requires understanding who is at risk and why, and options for intervention. We sought to understand the drivers of socioeconomic disparities in heat-related vulnerability in New York City (NYC), the perceived risk of heat exposure and climate change, and barriers to protective behaviors. A random digit dial telephone survey of 801 NYC adults aged 18 and older was conducted from September 22-October 1, 2015. Thirteen percent of the population did not possess an air conditioner (AC), and another 15% used AC never/infrequently. Odds of not possessing AC were greater for non-Hispanic blacks compared with other races/ethnicities, OR=2.0 (95% CI: 1.1, 3.5), and for those with low annual household income, OR=3.1 (95% CI: 1.8, 5.5). Only 12% reported going to a public place with AC if they could not keep cool at home. While low-income individuals were less likely to be aware of heat warnings, they were more likely to be concerned that heat could make them ill and that climate change would affect their health than participants with a higher household income, OR=1.6 (95% CI: 1.0, 2.3). In NYC, lack of access to AC partially explains disparities in heat-related health outcomes. Our results point to opportunities for knowledge building and engagement on heat-health awareness and climate change adaptation that can be applied in NYC and other metropolitan areas to improve and target public health prevention efforts.

## **P03.0060. Increasing Access to Cooling in the Community: A Trial Heat Relief Network for Toronto**

Kelly Sabaliauskas

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Abstract: Toronto Public Health (TPH) estimates that extreme heat contributes to an average of 120 excess deaths per year in Toronto. Very hot weather or extended periods of heat can increase health impacts among all people. Toronto Public Health coordinates the Hot Weather Response Plan under which key partners undertake activities aimed at reducing heat-related illness, including opening seven cooling centres when either a Heat Warning or Extended Heat Warning is in effect. Cooling Centres are designated air-conditioned locations that provide a place for people and their pets to escape the heat, rest, drink water, have a light snack and get information on how to prevent heat-related health impacts. To inform how Toronto can best offer cooling to vulnerable residents, in 2017, TPH conducted a jurisdictional scan of heat relief programs across North America and identified common features of heat relief facilities, including the following factors that make them more effective: 1) maximizing the number, and broadening the definition of facilities that are designated as heat relief facilities; 2) selecting facilities where people already choose to spend their time; and 3) allocating resources to promote and coordinate work. Based on the results of this scan, TPH will be promoting a Heat Relief Network that incorporates nearly 200 air conditioned libraries and community centres for the 2018 heat season. In addition, the Heat Relief Network will attempt to overcome barriers that prevent residents from using the existing Cooling Centre program including: limited access to transportation, fear or inability to leave home, stigma and reluctance to spend time in a place without activities. This presentation will focus on the population needs, program design, resident engagement and challenges encountered while implementing the Heat Relief Network.

## **P03.0070. Leveraging Community Partnerships to Advance Disaster Research Response: A Qualitative Analysis**

Erin Haynes

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**Abstract:** In response to concerns about increasing disasters, the NIH created the Disaster Research Response Program (DR2) as "the national framework for research on the medical and public health aspects of disasters and public health emergencies." We sought to identify perceived facilitators and barriers to community engagement (CE) in DR2 and examine how existing community partnerships can be leveraged to facilitate timely and effective DR2. We conducted key informant interviews with 15 National Institute of Environmental Health Science Environmental Health Science Centers Community Engagement Core (CEC) Directors. Interviews elicited information about current community partnerships and familiarity and experience with DR2. We also explored the possibility of developing a CE response team that could be rapidly deployed to disaster-affected communities to facilitate translational research and CE activities. Interview notes were inductively coded and qualitatively analyzed. Common barriers to CE in DR2 included lack of DR2 experience, complexity of coordinating multiple external research groups, issues related to rapid IRB approval or IRB coordination across institutions, perceived detrimental impacts to well-developed community relationships, and varying expectations and priorities among community groups and researchers. The importance of established working relationships with communities before a disaster occurs was a recurrent theme and emphasizes the important role that CECs and practice-based connections play in DR2. A DR2 CE response team was identified as an opportunity worthy of further exploration. The results of this study will help inform the NIH DR2 program and provide information on how to best quickly and effectively engage community partners when conducting DR2.

**P03.0080. The Relationship of Climate Variability and Particulate Matter on Birth Weight in Seoul, Republic of Korea**

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**Abstract:** Background: Birth weight is an indicator of in utero environment including exposure to environmental factors. Climate variability is associated with both meteorological factors and changes in atmospheric pollutant concentrations. The authors aimed at assessing the effect of climate variability and air pollutant on birth weight in an Eastern Asian metropolitan city. Methods: We have linked the individual birth data, Ocean Nino index, the particulate matter less than 10 µg in diameter (PM10) concentration, and the meteorological factors from 2000 to 2016 in Seoul, Republic of Korea. Using a generalized additive model, we analyzed the exposure-response relationship between average Ocean Nino Index, average temperature, and average PM10 during pregnancy and change of birth weight. Results: Birth weight significantly increased to 4.08 (95% CI. 2.80, 5.37) g per 1 degree Celsius increment of average Ocean Nino Index. Birth weight sharply decreased to -4.85 (95% CI. -6.84, -2.86) g per 10 µg/m<sup>3</sup> increment of average PM10 concentration. As the average temperature increased, the birth weight tended to decrease by -1.1 (95% CI. -4.65, 2.45) g per 1 degree Celsius increment, but it was not statistically significant. Conclusions: We have confirmed that the effects of climate variability, temperature and PM10 during pregnancy interact with each other. The rise in temperature due to climate change and air pollution can be important environmental risks affecting birth weight in the 21st century.

**P03.0090. The Exposure Science Aspects of the Re-Envisioning of the (U.S.) National Library of Medicine's Toxicology and Environmental Health Resources**

Shao Lin

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**Abstract: Background/Objective:** High ambient temperature is shown to influence birth outcomes, however, few studies have assessed heat's effect during the fetal development period on congenital heart defects (CHDs), especially in transitional seasons. We examined and compared the associations between extreme heat and CHD phenotypes in summer and spring, assessed their geographical differences, and compared different heat indicators. **Methods:** We identified all 5,848 CHD cases and 5,742 controls (without major structural defects) from the National Birth Defects Prevention Study, a United States (U.S.) multicenter population-based case-control study. Extreme heat events (EHEs) were defined by using 95th (EHE95) or 90th (EHE90) percentile of daily maximum temperature and its frequency and duration during postconceptional weeks 3-8. We used a two-stage Bayesian hierarchical model to examine both regional and study-wide associations. Exposure odds ratios (ORs) were calculated using multivariate logistic regression analyses, while controlling for potential confounding factors. **Results:** Overall, we observed no consistent relationships between maternal EHE exposure and CHDs in most regions. However, we found that 3-11 days of EHE90 in both summer and spring was significantly associated with ventricular septal defects (VSDs) study-wide (ORs ranged: 2.17-3.24). EHE95 in spring were significantly associated with conotruncal defects and VSDs in the South (ORs: 1.23-1.78). Most EHE indicators in spring were significantly associated with increased septal defects (VSDs and atrial septal defects (ASDs)) in the Northeast. **Conclusion:** While generally null results were found, longer heat durations were associated with increased risks for VSDs and ASDs, mainly in the South and Northeastern U.S., as well as transitional months in spring when using multiple heat indicators. Further research is needed to confirm our findings.

**P03.0110. Public Health Professionals' Perceptions of Dengue Control in the Face of Climate Change: A National Survey among China CDC Staff**

Peng Bi

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**Abstract:** Background: As an important climate-sensitive disease, dengue fever has been a serious public health problem in China, which is particularly important in the context of climate change. Health professionals play a significant role in the control and prevention dengue. The aim of this study was to explore public health professionals' perceptions of dengue control and prevention in the context of climate change in China. Methods: A cross-sectional survey was conducted among public health professionals of 15 Centres of Disease Control and Prevention (CDC) in China to gauge their perceptions of dengue control and prevention in the context of climate change. Descriptive analysis and logistical regression were performed. Results: In total, 1,051 questionnaires were distributed, and 973 questionnaires were completed. More than 75% of participants indicated climate change would affect vector-borne diseases, and more than 70% believed climate change would affect dengue fever, especially those from Southwest, Central and East China. Nearly 70% of participants from Yunnan Province and half from Prefectural/County CDCs indicated dengue re-emerged and occurred in new geographic areas. Furthermore, 41.4% of participants indicated current prevention methods and control programs were effective in reducing dengue incidence, and 35.4% thought the public was well informed about how to reduce the risk of dengue. Additionally, participants thought mosquitoes in high-density, imported cases, climate change and internal migrant population were main risk factors for dengue in China. Conclusion: This study found the majority of public health professionals endorsed that climate change would affect vector-borne diseases and dengue fever in China. Participants had perceived dengue emergence/re-emergence and expansion in geographic areas in certain regions. Most participants urgently advocated better dengue prevention methods and control programs, and health education for the public is needed.

### **P03.0120. Projected Temperature-Related Years of Life Lost from Stroke Caused by Climate Change**

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**Abstract:** Global warming has attracted worldwide attention. Numerous studies have indicated that stroke is associated with temperature; however, few studies are available on the projections of the burden of stroke attributable to future climate change. We aimed to investigate the future trends of stroke years of life lost (YLL) associated with global warming. We collected death records to examine YLL in Tianjin, China, from 2006 to 2011. We fitted a standard time-series Poisson regression model after controlling for trends, day of the week, relative humidity, and air pollution. We estimated temperature-YLL associations with a distributed lag nonlinear model. These models were then applied to the local climate projections to estimate temperature-related YLL in the 2050s and 2070s. We projected temperature-related YLL from stroke in Tianjin under 19 global-scale climate models and 3 different greenhouse gas emission scenarios. The results showed a slight decrease in YLL with percent decreases of 0.85%, 0.97%, and 1.02% in the 2050s and 0.94%, 1.02%, and 0.91% in the 2070s for the 3 scenarios, respectively. The increases in heat-related annual YLL and the decreases in cold-related YLL under the high emission scenario were the strongest. The monthly analysis showed that the most significant increase occurred in the summer months. Future changes in climate are likely to lead to an increase in heat-related YLL, and this increase will not be offset by adaptation under both medium emission and high emission scenarios. Health protections from hot weather will become increasingly necessary, and measures to reduce cold effects will also remain important.

### **P03.0130. Implementation of Real-Time Surveillance Data to Improve the Swedish Heatwave Early Warning System**

Christofer Åström

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**Abstract:** Background As heatwaves are becoming more common with climate change and with trends of increasing vulnerability to heat in Sweden, the role of the Swedish heatwave early warning system is becoming more important. Currently the warning system is managed by the Swedish Met Office and warnings are issued based on temperature alone. To further develop the warning system, we have investigated the possibility to use other types of real-time data to get better estimate of the health impacts from heatwaves. Methods Data on daily maximum temperatures and mortality was collected and combined with data on the number of calls to the nurse advise lines and over-hospitalization. We also investigated the effects of winter mortality on the temperature-mortality relationship during summer. Data was collected for Stockholm and Scania county. Results Findings show that the number of calls to the nurse advise lines for certain symptoms can act as an effect modifier for the heat-mortality relationship in the county of Scania, both the same day as well as in the coming days. A high winter mortality was associated with a lower risk during periods with high temperatures. Over-hospitalizations during heatwaves were associated with an elevated mortality risk, especially for cardiovascular mortality. Over-hospitalizations will also affect mortality in the near future case of a heatwave. Discussion the results suggest that the impacts of heat on mortality is altered by health data that might be available in real-time. This could be used to inform the early warning system and help the transition into a consequence based rather than a weather based system. This work is currently under way for other types of weather warnings and this type of input will increase community's possibility to make informed decisions on preventive actions prior to a heatwave.

### **P03.0140. Spatial and Temporal Characteristics of *Vibrio Parahaemolyticus* in the Chesapeake Bay**

Benjamin Davis

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Abstract: *Vibrio parahaemolyticus* naturally occurs in estuaries and is a leading cause of seafood-borne illness. It is therefore necessary to develop ecological prediction tools for shellfish harvesting waters. Such predictions need adequate spatial and temporal resolution as bacterium abundance fluctuates frequently. Previous work identified environmental determinants of *V. parahaemolyticus* in the tidal waters of the Chesapeake Bay using a large data set (n= 1,385) collected from 148 monitoring stations between 2007-2010. Regression models were developed using water samples analyzed by qPCR along with spatially- and temporally-indexed water quality data. Previously identified relationships with temperature and turbidity were confirmed, while more complex relationships were identified for nitrogen and phosphorus. Non-linear associations with salinity were determined to be a function of both low temperature and turbidity. Recent work attempted to develop *V. parahaemolyticus* prediction models using time-indexed and 1- and 2-month lagged water quality measures. Tobit regression models were evaluated using cross-validation methods to quantify prediction bias and uncertainty. The results were promising, indicating that water quality data can provide adequate prediction for bacterium presence and abundance, and that lagged measures provide complimentary or superior predictive power when compared to time-indexed measures. Current work is expanding variable selection for prediction models and increase the spatial-temporal extent of such predictions by using geostatistical interpolation techniques. These modeling efforts will culminate in a prediction tool that will provide real-time forecasts of *V. parahaemolyticus*. These prediction models will better inform shellfish harvesters and regulators on when and where preventative food safety post-harvesting practices are necessary.

### **P03.0150. Air Quality Related Health Co-Benefits of Mitigating Climate Change in South Korea**

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**Abstract:** Climate mitigation reduces fossil fuel consumptions and greenhouse gas emissions, which generally contribute to the reduction of air pollutant emissions. Bad air quality poses a threat to human health (mortality and morbidity), increases medical expenditure, and decreases labour supply. This study aims to quantify health co-benefits for air pollution reduction scenarios due to climate mitigation in both physical and monetary terms in South Korea. We used an integrated approach to consider an air quality model, a health assessment model, and an economic model to evaluate the long-term health and economic impacts caused by air pollution (PM<sub>2.5</sub> and ozone) under climate mitigation scenario and SSPs in South Korea. Climate mitigation towards 3.4 W/m<sup>2</sup> reduces 0.02 (95% C.I.: 0.01-0.04) million premature death under SSP2 in 2050 compared with reference year of 2005. Medical expenditure expected to be increased due to GDP escalation, amount of increase is 0.17 billion USD under SSP2, and 0.35 billion USD under SSP3. Work loss hours expected to be decreased by 3.19 hours per capita under SSP2 scenario. Net benefit of climate mitigation is more than 20 billion USD. Improved air quality could provide significant health benefits in near future.

**P03.0160. Nationwide Epidemiological Study of Stroke Occurrence and Temperature in China: Association, Susceptibility and Risk Burden**

Tianjia Guan

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Abstract: Stroke, a leading issue of public health has been linked to outdoor temperature. However, the association has been rarely examined by nation-scale study in China. Making use of 11,144 stroke (including ischemic and hemorrhagic stroke) or transient ischemic attack (TIA) patients from 339 communities and temperature estimates from an assimilation of in-situ observations, satellite measurements and simulates of Weather Research Forecast model, we conducted a case-crossover study during 2000-2016. Occurrence of stroke or TIA was associated to temperature anomaly by a lag-distributed nonlinear model. The variations of the association were further explored by strata of subpopulations and by geographic regions. Attributable fraction was finally derived to quantify risk burden of stroke. Either ischemic or hemorrhagic stroke was strongly associated to both cold or heat temperature at different lags, while TIA was weakly linked to cold weather at lag 0 day. During lag 0-2 day, the risk of stroke increased by 20% (95% confidence interval: 3%, 40%) for extreme cold or 19% (3%, 37%) for extreme heat. We also found that re-occurred stroke was more strongly associated to temperature than first stroke. In China, irregular variation of temperature might attributed 3.42% of stroke attacks. More stroke occurrences were attributed to heat (2.05%) than cold (1.38%). During 2000-2016, stroke risk was estimated to increase by 0.02% per year with the changed temperature, particularly the increment of heat events. Our findings enrich epidemiological evidences on the association between stroke and temperature, and support China's policymakers to plan stroke prevention and climate change mitigation.

### **P03.0170. Daily Ambient Temperature Is Associated with Biomarkers of Kidney Injury in Older Americans**

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**Abstract:** **INTRODUCTION:** Increases in ambient temperature have recently been associated with increased risk of hospital admission for a number of kidney pathologies. However, how increased temperature might affect renal pathophysiology has not yet been elucidated. **METHODS:** Multiple regression models evaluated the association between 1- and 3-day average, ambient temperature levels and biomarkers of kidney injury (neutrophil gelatinase-associated lipocalin (NGAL) and adiponectin), among 3,377 individuals over 57 years of age enrolled in the National Social Life, Health, and Aging Project. Mediation of the affects of temperature through blood pressure was also explored. Temperature estimates were based upon data from the National Climatic Data Center (NCDC) and spatially smoothed on a six-kilometer grid covering the U.S.. Models were adjusted for demographic, socioeconomic, health behavior, medical history variables, and ambient particulate matter. **RESULTS:** Individuals in the top quartile of daily temperature (>200C) had 16.10% (SE 5.70%, p=0.008) higher levels of NGAL and 28.03% (SE 6.35%, P<0.001) higher levels of adiponectin relative to those in the lower quartiles. Associations for 3-day average exposures were attenuated (NGAL: 9.90%, SE 5.61, p=0.086; Adiponectin: 20.96%, SE 6.28%, p=0.002). Spline curves of continuous temperature exposures identified significant non-linearity, with non-significant associations for ambient temperatures <100 C, and significant, linear effects for ambient temperatures ≥100C. In models restricted to exposures ≥100C, each 10C increase was associated with 1.98% (SE 0.58, p<0.001) higher NGAL and 2.77% (SE 0.63, p<0.001) higher adiponectin levels. Significant mediation was not identified. **CONCLUSIONS:** In a cohort of older Americans, daily ambient temperature exposures were significantly associated with biomarkers of acute renal injury. These associations suggest that ambient temperature exposures may be an important risk factor for acute kidney injury.

### **P03.0180. Sex as Effect Modifier of the Association between Daily Wet-Bulb Temperatures and Kidney Stones Presentations**

Ana Vicedo-Cabrera

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**Abstract:** Background and aim: Compared to female mammals, males have greater evaporative water loss and renal water reabsorption, which affects urine volume, a determinant of kidney stone formation. In this contribution, we assessed whether sex modifies the relationship between temperature and emergent presentations for kidney stones. Methods: We collected data from 132,597 individuals who presented with kidney stones to 68 emergency departments throughout South Carolina from 1997 to 2015. Daily weather variables at ZIP code level were collected through NASA Land Data Assimilation Systems. We performed an aggregated case-crossover study at zip code level, applying distributed lag nonlinear models to explore the non-linear and lagged association between daily kidney stones presentations and maximum daily wet-bulb temperatures over 10-days. We assessed effect modification through interaction terms between sex indicator and the cross-basis term of maximum daily wet-bulb temperatures. We also explored interactions by other individual characteristics such as age, race, payer status, and climate. Results: Compared to 10°C, daily wet-bulb temperatures at the 99th percentile were associated with a 73% increased risk of kidney stone presentations among males (95% confidence interval: 1.56-1.91) and a 15% increased risk among females (1.01-1.32; interaction  $p < 0.001$ ). There were weak differences by age, race, and climate that were not statistically significant, and no differences between private versus public insurance. Conclusion: Our results suggest a greater risk of presenting kidney stones in males after the exposure to extremely high temperatures. These findings have implications for clarifying the impact of climate change on human health and suggest that strategies to mitigate the effect of high temperatures may produce the greatest public health benefit for men at risk for kidney stone presentation.

### **P03.0210. Health Co-Benefits and Impacts of Transitioning from Fossil-Fuel Based to Cleaner Energy Sources in Higher-Income Countries: What Do We Know?**

Rachel Tham

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**Abstract:** Background: It is hypothesised that transitioning from traditional fossil fuel use to cleaner energy sources will have significant environmental benefits and health co-benefits related to reduced air pollution. However, little is understood with regard to potential adverse health impacts of new energy forms. Aim: To systematically synthesise current research that examined shifts to cleaner energy sources with specific consideration of health co-benefits. Method: Systematic search of PubMed, Medline and EMBASE databases and hand-searching for peer-reviewed studies published in English to 24 January 2018. Inclusion criteria: energy use or energy transition related to health outcomes or co-benefits; epidemiological, health impact assessment, modelling or hypothesised. Results: Of 5031 articles found, 58 original research and 14 review papers were considered. Few papers explicitly considered health benefits of energy transitions other than climate change scenarios. Papers were in key areas: biofuels; photovoltaic (PV) cells (solar panels); wind turbines; electrification of vehicles; modelling climate change policies; increased or decreased energy consumption and improved air quality; econometric modelling; and improved residential energy efficiency. Key findings were 1) biofuels, electric cars, PV cells and wind turbines may produce lower levels of air pollutants but there may be health risks associated with their production, use or disposal that needs to be incorporated in the overall assessment of health effects; and 2) environmental justice issues arise when an inequitable health burden is placed on poorer communities living near sites of electricity production while wealthier sectors benefit from newer technologies which are currently expensive e.g. electric vehicles. Conclusion: The degree of health benefit varies with the energy technology type. There is a need for targeted health impact assessments that incorporate life cycle assessment of newer energy technologies.

### **P03.0220. Accessing Heat Effects among Migrant and Seasonal Farmworkers: A Multi-State Study**

Kai Zhang

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**Abstract:** Background: Although migrant and seasonal farmworkers are highly vulnerable to ambient heat because of their working conditions, heat effects in this population have been rarely studied. Objectives: We estimated effects of heat on mean daily counts of clinic visits among migrant and seasonal farmworkers by taking advantage of a unique longitudinal medical records database in the USA. Methods: We compiled a daily weather and clinic visit data set based on data from five health centers located in five states (California, Colorado, Michigan, New York and Washington) for the summer of 2011-2014. A total of 303, 121 patients were included in our analysis, including 87, 687 migrant farmworkers and 215,965 seasonal farmworkers. We used Poisson regression to estimate the associations between heat and daily all-cause clinic visits among migrant or seasonal farmworkers or other clinic patients. We defined heat effects as the percentage difference in average daily counts of clinic visits, comparing 90-50th percentiles of daily mean apparent temperature, a composite index accounting for both temperature and humidity. We conducted a sensitivity analysis to evaluate the impact of adjustment for ozone levels and different heat definitions. Results: Although we did not observe statistically significant associations between heat and clinic visits among migrant and seasonal farmworkers across five centers, point estimates of heat effects are positive up to 6.5% for migrant farmworkers in two centers (Colorado and Michigan) and positive up to 16.3% for seasonal farmworkers in three centers (Colorado, Michigan and Washington). Conclusions: Our study appears to be the first to link heat effects with clinic data among migrant and seasonal farmworkers. This research suggests possible meaningful impact of heat on migrant farmworkers and provides justifications for further studies.

### **P03.0230. National Weather Service Heat Alerts and Emergency Hospital Admissions among the Elderly in 97 U.S. Counties**

Kate Weinberger

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**Abstract:** Background: In an effort to reduce heat-related mortality and morbidity, the US National Weather Service issues heat alerts in advance of forecast extreme heat events to communicate risk to the public and government officials. However, in a previous analysis of 20 cities, we found no evidence of a protective association between heat alerts and mortality between 2001-2006, except in Philadelphia, Pennsylvania. The impact of heat alerts on measures of morbidity, especially in more recent years, remains unknown. Objective: To quantify the association between heat alerts and emergency hospital admissions among Medicare beneficiaries age  $\geq 65$  years living in 97 US counties, 2007-2012. Methods: We used overdispersed Poisson regression models to estimate the association between heat advisories and excessive heat warnings (collectively, heat alerts) and daily counts of emergency and urgent hospital admissions for any cause exclusive of external injuries. We adjusted for daily maximum heat index (lags 0-2), year, month, day of week, and federal holidays, as well as lagged heat alerts (lags 1-2). We pooled results across counties into a summary measure using standard meta-analytic methods. Results: Overall across the 97 counties, we did not find evidence of an association between heat alerts and hospital admissions (percent change in admission rate comparing days with versus without heat alerts: -0.1% [95% CI: -1.0, 0.7], p-value for heterogeneity: 0.94). We did not observe differences by sex, age group, or geographic region of the country. Conclusions: We did not find evidence that National Weather Service heat alerts are associated with lower rates of hospital admissions among the US elderly. The identification of factors that drive heat alert effectiveness is critical as the frequency and severity of extreme heat events is expected to increase over the 21st century due to climate change.

### **P03.0240. Temperature-Related Hospital Outpatients for Cardiovascular and Respiratory Diseases in Seven Major Cities of South Korea**

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**Abstract:** Background: There is limited evidence on ambient temperature effects on hospital outpatients for cardiovascular respiratory diseases. This study assessed the temperature effects in seven major cities (Seoul, Busan, Incheon, Daegu, Gwangju, Daejeon and Ulsan) of South Korea  
Methods: A time-stratified case-crossover design was used to assess relationship of daily mean temperature with hospital visits for hypertension (I10), ischemic heart disease (I20-25), heart failure (I50), cerebrovascular diseases (I60-69), pneumonia (J12-18), allergic rhinitis (J30), asthma (J45) and chronic lower respiratory diseases (J40-44) during the period of 2008-2015. City-specific distributed lag non-linear models were fitted using a conditional Poisson regression with over-dispersion. Lag intervals up to previous 14, 21 and 28 days of exposure were considered. Relative humidity, air pressure, holiday and influenza epidemic were adjusted for. Multivariate meta-analysis was conducted. Results: We found associations between low temperature and hospital visits for cardiovascular and respiratory diseases. For instance, compared to those at 50th percentile of temperature (14.8C), the pooled cumulative associations up to previous 21 days of exposure (cumulative relative risk) at 1st percentile of temperature (-6.6C) for hospital visits for hypertension and ischemic heart diseases were 1.23 (95% CI: 1.17, 1.30) and 1.14 (95% CI: 1.05, 1.24) respectively. Compared to those at 10th percentile of temperature (-0.6C), the pooled cumulative associations at 1st percentile of temperature (-6.6C) for hospital visits for allergic rhinitis and asthma were 1.15 (95% CI: 1.07, 1.25) and 1.09, (95% CI: 1.01, 1.18) respectively. Conclusion: This study suggests that exposure to ambient low temperature increases risk of hospital visits for cardiovascular and respiratory diseases.

### **P03.0250. Extreme Weather Conditions and Non-Cancer Mortality among Elders in Taiwan**

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**Abstract:** Background: Global climate change increases the frequency of extreme weather conditions, which may contribute to mortality risk, especially in vulnerable populations. Information on personal risk factors for extreme weather related mortality is still limited. Method: This studied included 115,856 adults over 65 years old participated geriatric health examination program between 2005 and 2012 in Taipei, Taiwan. Among this cohort, 12,958 elders died before 31 Dec 2012. The death month was retrieved from the National Death Registry. Extreme weather conditions were assessed at the residential townships. The among number of extreme weather days were calculated each month. For control period, case-crossover design was used to define the month before the death month. To evaluate the association between extreme weather conditions and mortality, Cox proportional hazard regression with the penalized smoothing spline was applied. The modification effects of several personal factors, including age, gender, lipid profile, renal function, uric acid, and thyroid function were also examined in this study. Results: Non-cancer mortality was associated with several characters of extreme temperature, including the monthly averaged IQR of daily temperature > 4Celsius(HR 1.10, 95%CI 1.03, 1.18), the monthly averaged day-time maximum temperature > 34Celsius (HR 1.11, 95%CI 1.02, 1.21), and the monthly number of extremely heat night days >12 days (HR 1.11, 95%CI 1.00, 1.23). If dividing the cohort by median age of death, significant effects of aforementioned weather conditions were only found among those >83 y/o. We didn't found potential modification effects of other biochemical markers. Conclusion: Higher variability of daily temperature and extremely heat night are associated with higher non-cancer mortality among elders, especially in older age group. Further studies are needed to identify underlining social and biological mechanisms.

### **P03.0260. Suicide and Ambient Temperature: A Multi-City Multi-Country Study**

Yoonhee Kim

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**Abstract:** Previous literature suggests that higher temperature may play a role in increasing the risk of suicide, but little is known about the nonlinear temperature-suicide association. We examined a nonlinear exposure-response curve of the short-term association using a daily time-series data covering 294 locations in 10 countries (Brazil, Canada, Japan, South Korea, Philippines, Spain, Taiwan, UK, USA, and Vietnam) ranging from 4 to 40 years. We conducted a two-stage meta-analysis. In the first stage, we conducted a location-specific time-stratified case-crossover analysis to examine the short-term association between suicide and temperature (daily mean) using conditional Poisson regression. A distributed lag nonlinear structure for temperature was incorporated with the maximum lag of 6 days. In the second stage, we used a multivariate meta-regression to combine the location-specific lag-cumulative nonlinear associations by country and identify a range of temperature with the highest risk of suicide. In general, higher temperature was associated with the increased risk of suicide. However, suicide risk decreased rather than increased during extremely high temperatures (inverted J-shaped curve) in some locations, particularly for northeast Asian countries. The temperature with the highest risk of suicide for each country ranged from 91st to 99th percentile except the Philippines and the USA. The country mean cumulative relative risks at the temperature with the highest risk relative to that at the lowest were fairly consistent across countries, ranging from 1.27 (95% CI= 1.15-1.40) in the UK to 1.70 (95% CI= 1.35-2.15) in Taiwan, except for Vietnam at 2.69 (95% CI= 1.10-6.56). We found nonlinearity of the short-term temperature-suicide association. Our findings suggest that there may be a critical range of temperature that maximizes the risk of suicide, with the risk less high at extremely high temperature such as heat waves. On behalf of the MCC collaborative research network.

### P03. Built Environment, Noise and Greenness 3

#### **P03.0280. Urban Greenness Extracted from Pedestrian Video and Its Relationship with Surrounding Air Temperatures**

Sarah Henderson

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**Abstract:** Background: Urban greenness has been associated with a wide range of health benefits, partially attributable to local cooling and visually-stimulated stress reduction. Several approaches have been used to assess greenness exposure at individual and population scales, but there is discrepancy between methods. Image processing of pedestrian video data, collected as part of a study on microscale urban air temperature, provide a novel source of street-level information on vegetation. Methods: Python was used to extract green, yellow, and shaded pixels from ~10 million frames of video footage collected during 40 sampling runs of 20 urban routes measuring 8-10 km. Resulting greenness values (combined total of green, yellow, and shaded pixels as a percentage of all pixels) were compared with concurrent air temperatures using correlations, time series plots, and maps. Shaded pixels were included because vegetation can generate large shaded areas on hot summer days. Results: The mean air temperature measured across the 40 runs ranged from 19.8 to 31.9 °C, with standard deviations ranging from 0.26 to 1.21 °C. In comparison, the mean greenness ranged from 52% to 65%, with standard deviations ranging from 6% to 13%. Correlations ranged from -0.61 to 0.34 and were in the expected direction for 31 of 40 runs, with plots and maps showing clear inverse relationships in many cases. Flat and weakly positive relationships occurred when background temperatures were low, conditions were overcast, or routes were closer to large waterways. Conclusions: Secondary data are limited for such evaluations, but with further refinement, our methods could provide unprecedented spatial and temporal resolution for greenness exposure assessment in individual-level studies. They could also be used to evaluate and compare models used to assess exposure at the population scale as long as the video footage is temporally matched with other methods, such as satellite overpasses or Google Street View imaging.

### **P03.0290. Built Environment Features Associated with Street Scape Attractiveness in 56 Cities across 28 Countries**

Andrew Larkin

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**Abstract:** The built environment influences human health through several pathways, including environmental exposures and physical activity. Psychological pathway are also important but are not well understood given the difficulty in measuring related constructs (e.g. built environment attractiveness) and the specific components of built environments that contribute to these constructs (e.g. trees, density, mixed land use, etc.). We leveraged a novel crowdsourced data set (MIT Pulse Place) that included over 1.5 million pairwise comparisons of 424,929 Google street view images from 56 Cities across 28 Countries where individuals selected the image that was more beautiful. From these ranking we calculated a q-score for each image that ranged from 0 (lowest attractiveness) to 10 (highest attractiveness). We then derived multiple estimates of urban composition for each image to identify specific components of the built environment that are associated with streetscape attractiveness. We utilized a feature extraction deep learning algorithm to derive estimates of visible percent grass, trees, cars, sidewalks, roads, bushes, persons, houses, and sky from each image. Satellite-based estimates of road density, annual maximum NDVI, percent tree cover, population density, impervious surface area, and annual mean NO<sub>2</sub> and PM<sub>2.5</sub> were also derived from 100 and 250 meter radius buffers around the street view image locations. Preliminary results indicate that urban green space, especially tree canopy cover, is a particularly important driver of streetscape attractiveness. We are currently utilizing correlation globes, lasso variable selection, and regression modeling to further disentangle the relationships between built environment features, environmental exposures and attractiveness perceptions. A better understanding of these relationships will be used to inform future built environment health studies as well as policy and planning principals.

### **P03.0310. Green Spaces and Colon Cancer Risk: A Case-Control in Spain**

Cristina O'Callaghan-Gordo

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**Abstract:** Introduction: Green spaces have been associated with positive effects on various health outcomes. Few studies also suggest protective effect for cancer risk. Mechanisms explaining the beneficial effect of green spaces include increases in physical activity and reduced body mass index, both linked to colon cancer risk. Methods: We collected residential information for 1243 colon cancer cases and 3297 sex, age and area matched community controls between 2008-10 in 11 provinces (18 hospitals catchment areas) of Spain. We geocoded the longest residence of each participant and we assigned three indicators of exposure to green spaces within 300 m buffer: Access to urban green areas (>0.5 Ha) according Urban Atlas; access to agricultural areas according to CORINE Land Cover 2006; and surrounding greenness according to the average of the Normalized Difference Vegetation Index (NDVI). Detailed information on covariates was obtained. We used mixed models with hospital as random effect. All models were adjusted for age, education and socio-economical status (individual and area). We explored potential mediation effect by physical activity or body mass index (BMI). Results: Reduced risk of colon cancer was observed among those living close to urban green spaces [OR (95% CI)= 0.59 (0.47-0.75)]. Access to agricultural areas was associated with increased risk of colon cancer [OR=1.48 (1.22-1.8)] and with surrounding greenness [OR=1.19 (1.09-1.3)]. There was no suggestion for mediation by physical activity or BMI. Conclusion: The association between residential proximity to green spaces and risk of colon depends on the type of green space. Access to urban green spaces is associated with reduced risk of colon cancer, whereas access to agricultural is associated with increased risk. The mechanisms explaining this association are not clear.

### **P03.0320. Epigenetics, Built Environment and Atopy**

Hind Sbihi

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**Abstract:** Rationale Accurate estimation of gestational age (GA) using DNA methylation (DNAm) of umbilical cord blood, a novel development, provides relevant information on developmental stage. Studies of environmental exposures on GA are plentiful, but not using DNAm GA. We evaluated associations between DNAm GA, environmental correlates of the built environment and atopy. Methods Cord blood samples from 145 selected participants in the Canadian Healthy Infant Longitudinal Development study were examined, together with allergy skin prick tests at age 1 year. Exposure to greenness using satellite imagery, and individual exposure estimates to air pollution using land use regression models were assessed at home addresses throughout pregnancy. Associations of air pollution and greenness with DNAm GA residuals were tested while adjusting for maternal and neonatal characteristics. We further examined whether sensitization related to these environmental factors and DNAm GA. Results The mean GA was 276 (SD: 7.9) days, and mean DNAm GA was 279(5.8) days. There was a significantly positive correlation between these measures ( $r=0.66$ ;  $p<0.001$ ). Prenatal exposure to greenness showed borderline association with DNAm GA acceleration (i.e., older DNAm GA than chronological GA) (0.6 days, 95% CI: [-.6; 1.8] for one IQR exposure increase). Conversely, DNAm GA deceleration (i.e., younger DNAm GA) was associated with air pollution exposure during the first trimester (-2.1 days [-4.8; 0.7] for a 10  $\mu\text{g}/\text{m}^3$  exposure increase). 29% of this atopy-enriched sub-cohort were sensitized to at least one of 10 allergens. DNAm GA was a strong predictor of decreased risk of sensitization (OR: 0.93, 95%CI: [0.88; 0.99]), while air pollution exposure modestly increased the risk of sensitization by 4% ( $p=0.1$ ). Conclusion Our findings warrant in depth investigation of potential mediating role of DNA methylation on the association between allergic disorders and the built environment.

### **P03.0330. Health Impacts of Bike Sharing Systems in Europe**

David Rojas-Rueda

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**Abstract:** Background: Bike-sharing systems (BSS) has been implemented in several cities around the world as policies to mitigate climate change, reduce traffic congestion, and promote physical activity. This study aims to assess the health impacts (risks and benefits) of major BSS in Europe. Methods: We performed a health impact assessment study to quantify the health risks and benefits of car trips substitution by bikes trips (regular-bikes and/or electric-bikes) from European BSS with more than 2000 bikes. Four scenarios were created to estimate the annual expected number of deaths (increasing or reduced) due to travelers exposure to physical activity, road traffic fatalities, and air pollution (PM2.5). A quantitative model was built using data from transport and health surveys and environmental and traffic safety records. The study population was travelers between 18 to 64 years old. Results: Twelve BSS were included in the analysis. In all scenarios and cities, the health benefits of physical activity outweighed the health risk of traffic fatalities and air pollution. In the current scenario of car trips substitution by BSS in these twelve cities was estimated an annual reduction of 5.17 (95%CI: 3.11-7.01) deaths, corresponding to an annual saving of 18 million of Euros. A hypothetical scenario was also build to estimate the potential of BSS if they substitute car trips. In this hypothetical scenario was estimated an annual reduction of 73 deaths (225 million Euros saving) in the twelve cities. Conclusions: The twelve major Bike-sharing systems in Europe provide health and health-economic benefits. The promotion of shifting car drivers to BSS can significantly increase those health benefits. BSS in Europe can be used as a tool for health promotion and prevention.

### **P03.0340. Traffic-Related Air Pollution, Noise and Infant Mortality in London**

Mireille Toledano

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**Abstract:** Background There is evidence that ambient air pollution is associated with increased risk of infant mortality. Road traffic is a major contributor to ambient air pollution, but it also generates noise. This study investigates long-term exposure to both traffic-related air and noise pollution and risk of infant mortality. Methods We conducted a matched case-control study of infant deaths (deaths occurring in 1st year of life) from singleton births across Greater London from 2003-2010. Controls were singleton births in the study area between 2003-2010 surviving to age 1. Cases were matched to controls (n=29) on birthdate and sex. Monthly concentrations of NO<sub>2</sub>, NO<sub>x</sub>, source-specific traffic-related PM<sub>2.5</sub>, PM<sub>2.5</sub>, PM<sub>10</sub> and ozone were estimated at 20x20m resolution using a dispersion model, and time-weighted averages calculated for pregnancy/trimesters and birth to case death at address-level. Road traffic noise was modelled at address-level. We analysed the relationship between air pollutants/noise and infant mortality using conditional logistic regression, with adjustment for confounding. Results The study population comprises 3390 infant deaths (69% neonatal, 31% postneonatal). Average air pollutant exposures for cases from birth to death were 42µg/m<sup>3</sup> NO<sub>2</sub>, 77µg/m<sup>3</sup> NO<sub>x</sub>, 15g/m<sup>3</sup> PM<sub>2.5</sub>, 24g/m<sup>3</sup> PM<sub>10</sub> and 31g/m<sup>3</sup> O<sub>3</sub>. Average day- and night-time noise levels were 58 and 53 dB respectively. Higher road traffic air pollution and noise exposures were particularly associated with non-White ethnicity and lower socio-economic status. Preliminary results from adjusted single-pollutant models suggest increased risk of infant mortality associated with higher ozone exposure, but not with other air pollutants or noise. Analyses of joint air pollution-noise exposures are currently underway. Conclusions To our knowledge, this is the first epidemiological study to investigate risk of infant mortality in relation to both road traffic air pollution and noise co-exposures.

**P03.0350. Assessing the Contribution of Noise to the Association between Traffic-Related Air Pollution and Children's Respiratory Health**

Meredith Franklin

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**Abstract:** Traffic emissions are comprised of a complex mixture of components including tailpipe emissions, non-tailpipe emissions, and noise. While regulations have resulted in drastic reductions in tailpipe emissions, growing vehicle fleets and miles traveled have contributed to increased noise and non-tailpipe emissions such as brake wear, tire wear, and associated resuspended road dust. It is critical to assess effects of these lesser-studied non-tailpipe exposures particularly of noise, which can amplify the detrimental health effects associated with near-roadway exposure. Exposures to traffic noise, estimated from the Federal Highway Administration Traffic Noise Model (TNM), and NO<sub>x</sub>, estimated from a line-dispersion model, were spatially linked to the residential locations of children in the Southern California Children's Health Study. Lung function and asthma status were assessed for 1,397 children, and additional personal characteristics were recorded. Generalized additive mixed effects models were fit to assess the marginal and joint associations between NO<sub>x</sub>, noise and respiratory outcomes. In an adjusted model we found a 14.5 mL (95 % CI: -40.0, 11.0 mL) decrease in forced vital capacity (FVC) per interquartile range (13.6 ppb) increase in NO<sub>x</sub> that was strengthened to a statistically significant 34.6 mL decrease (95% CI: -66.3, -2.78 mL) after adjusting for a non-linear function of noise. The associations with FEV showed a similar result. Without taking noise into account we would have drastically underestimated the detrimental effects of exposure to traffic-related pollution, indicating the importance of jointly assessing multiple traffic-related pollutants. Further contributions of noise measured at intersections, as well as other important factors including particulate matter metals and neighborhood greenspace, enhanced our assessment of the full effects this multipollutant mixture on respiratory outcomes in a children.

**P03.0360. Association between Exposure to Noise and Sleep and Mental Health Outcomes in a Nationally-Representative Sample of U.S. Adolescents**

Joan Casey

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**Abstract:** Background: In 1974, the U.S. Environmental Protection Agency (U.S. EPA) identified an equivalent 24-hour continuous average noise exposure level (LAeq, 24h) of < 55 A-weighted decibels to protect public health with an adequate margin of safety. To date, however, limited U.S.-based research has evaluated the relationship between noise pollution and health. We help fill this gap using data from a nationally-representative sample of U.S. adolescents. Methods: We used a cross-sectional geospatial sound model to estimate noise exposure at the block group level. We dichotomized noise as high (LAeq, 24h ≥ 55 dB) versus low (LAeq, 24h <55 dB). The National Comorbidity Survey Adolescent Supplement, conducted between 2001-2004 and including several self-reported sleep outcomes and DSM-IV disorder diagnoses, provided our study population. We evaluated the association between noise and sleep and mental health using doubly-robust targeted minimum loss-based estimation and propensity score matching to account for potential confounders, including air pollution. Results: The study included 4,508 urban-dwelling adolescents aged 13-18. Controlling for numerous adolescent, household, and environmental covariates, living in a high- versus low-noise census block-group was associated with later bedtimes on both weeknights and weekend nights (risk difference [RD]: 0.41 hours, 95% CI: -0.01, 0.83, and RD: 0.61 hours, 95% CI: 0.38, 0.84, respectively). We found no association with total number of hours slept. Further, we found that living in a high- versus low-noise census block-group was associated with 69% increased odds of an anxiety or depressive disorder (odds ratio [OR]: 1.69, 95% CI: 1.13, 2.25) and 79% increased odds of substance use disorder (OR: 1.79, 95% CI: 0.91, 2.66); we found no similar associations with behavioral disorders. Conclusion: We found evidence that noise exceeding the U.S. EPA threshold may hold adverse sleep and mental health consequences for U.S. adolescents.

### **P03.0370. Residential Green Space and Mental Health: Analyses of the Cartagene Population Cohort's Data**

Nolwenn Noise!

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**Abstract:** Built environment including green space may have an impact on health status like stress, cardiovascular diseases and mortality. However, little research has examined the effects on mental health, especially on a long-term frame. This study aims to explore the associations between depression, anxiety and exposure to green space using the CARTaGENE population cohort databases. The CARTaGENE Cohort databases were used in this study. Participants from urban area (Quebec, Canada) with residential history (>5years) were selected (n=8,144). Green space exposures were estimated using satellite derived measures (NDVI). Health outcomes included depression and anxiety determined through different manners: Administrative health databases, self-reported medical diagnosis, Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder (GAD-7) scales. Linear and logistic multivariate models were used to determine associations between green space exposures and mental health. Some evidence that urban green space is associated with decreased depression and anxiety were observed, although the magnitude of association varied by assessment method. A 0.1 increase in residential NDVI (100 m radius) was associated with an OR of 0.89 (95% CI: 0.81-0.98) for ever having a self-reported medical diagnoses of depression and 0.95 (95% CI: 0.88-1.03) for depression assessed through administrative health databases in the previous 10 years. For participants who have moved in a greener environment in the last 5 years, PHQ-9 and GAD-7 scores are lower (-0.37 and -0.30, respectively, p<0.05). This study demonstrates the potential of using population cohort databases to address environmental health issues. The CARTaGENE databases have the advantages to collect long-term health data (>10 years) and to allow the linkage with other databases. Trends arising from the analysis showed associations between green space and mental health that are highly dependent on the data sources.

**P03.0390. Assessment of the Impact of New Subway Stations on Public Transit Mode Share Using a Quasi-Experimental Design (Montreal, Canada)**

Sophie Goudreau

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**Abstract:** The use of public transit has been associated with increased physical activity through increased walking compared to car use, and thus to increased health benefits. Yet how increased public transit access has modified the use of public transit has received very limited attention. We aimed to assess the impact of three new subway stations in 2007, on the use of public transit in the greater Montreal region (Canada), with a quasi-experimental design. We used information from Origin-Destination (OD) surveys of 2003, 2008 and 2013 to assess public transit mode shares in 96 OD survey areas. We compared mode shares in the OD area where the subway stations was added (intervention area), to those of comparable control areas with no new subway stations. Those control areas were identified with a cluster analysis based on the 2003 characteristics of the areas related to transport behaviors (i.e. mode shares), built environment characteristics (e.g. population density, proximity to subway stations) and the socio-economic status of the residents (estimated with information from the 2001 Census). Mode shares were compared using difference-in-difference models, with matching of individuals from the OD surveys based on age, sex and income with propensity scores. Six out of 96 control areas were selected with the cluster analysis. The public transit mode share increased from 13% (2003) to 18% (2013) in the intervention area. This increases (+5%) is significantly greater than in control areas with no new subway stations (-1.9% to 1.9%). Thus, after 10 years, the differences in the evolution of public transit mode share between the intervention and each control areas ranged from +3.1% to +6.9%. The addition of new subway stations is associated with a non-negligible increase in public transit mode share, and future assessments should quantify its influence on physical activity and health.

**P03.0400. Exposure to Green Areas as a Way of Enhancing Health and Resilience in Cities: Metropolitan Area of Guadalajara, Mexico**

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**Abstract:** Background/Aim: In rapidly-growing cities and urban settlements, green areas are identified as strategic zones to promote health, prevent disease and increase the resilience of individuals and communities. The aim of this study is to analyze the beneficial effects on health derived from the biodiversity in the green areas (urban parks) of the Metropolitan Area of Guadalajara (ZMG). Method: We identified urban parks > 100 hectares and a greater affluence of visitors in the ZMG. Five hundred surveys with open-ended and close-ended questions were answered by a sample of users above fifteen years of age. Data was collected on the reasons for their visits to the park, preferred sites within the park, activities undertaken and perceived benefits on their health. Through examination and observation, we recorded the ecosystemic services that exist in the park, the sites visited by users, their characteristics and appealing features. Findings: The green areas with more biodiversity and a greater opportunity to be exposed to microbiomes (freshness, presence of animals, scents) influenced activities such as walking, in a proportionally greater ratio (15%) than in parks where there is only recreational infrastructure. Likewise, tranquility (18%), relaxation (17%) and peace and quiet (15%) were also reported in a greater proportion, as benefits obtained in places with a greater biodiversity. In green areas, the preferred sites were gardens with diverse plant forms and textures, areas with animal presence or contact with animals and water (71%). Conclusions: When biodiversity and exposure to microbiomes are increased in green areas, more opportunities to benefit health are created and generates resilience among the people who visit them. Freshness in the environment, the presence of animals and scents were identified as beneficial exposure, derived from green areas which create a positive moods and reduce mental stress.

**P03.0410. Cardiovascular Diseases in Middle Aged and Older Adults in China: The Joint Effects and Mediation of Different Types of Physical Exercise and Neighborhood Greenness and Walkability**

Jun Wu

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**Abstract:** Both physical exercise and built environment have been associated with cardiovascular diseases (CVDs). Yet, few studies examined the influence of different types of physical exercise and multiple dimensions of built environment, their joint effects, and whether physical exercise mediates the effect of built environment on the risk of CVDs. We investigated different types of physical exercise and two important dimensions of built environment, namely greenness and walkability, on the risk of three common CVD outcomes (i.e. hypertension, coronary heart disease, and stroke) in a Chinese population aged 40 years or older. Data were collected for 1,944 residents from 32 communities across urban, suburban, and rural areas in Longzihu district of Bengbu, a typical second-tier city in China. Physical exercise was obtained from questionnaire surveys. Built environment factors included satellite-based Normalized Difference Vegetation Index (NDVI), Walk Score index, and questionnaire-based Neighborhood Environment Walkability Scale (NEWS). Multilevel logistic regression was used to estimate the associations of physical exercise and built environment with CVDs while accounting for within-community and within-subdistrict correlations and potential confounders. Significant associations were found for reduced risk of hypertension and coronary heart disease with walking/square dancing and Tai Chi, and reduced risk of stroke with walking/square dancing. Significant associations were also identified for reduced risk of hypertension, coronary heart disease and stroke with NDVI. Lower risk of hypertension and coronary heart disease was associated with higher Walk score; and lower risk of hypertension and stroke was associated with higher NEWS-based walkability score. We observed no interactions between physical exercise and the built environment, but physical exercise partially mediated the effects of greenness and walkability on the risk of CVDs.

### **P03.0420. Exposure to Artificial Light-At-Night and Obesity in a Population-Based Case-Control Study in Spain (MCC-Spain)**

Manolis Kogevinas

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**Abstract:** Background. Exposure to light-at-night and circadian disruption may increase cancer risk. In experimental animals light-at-night is strongly associated with obesity. We evaluated the association of exposure to artificial light-at-night (ALAN) with obesity in a population based multicase-control study. We applied a novel method for exposure assessment examining visual light and blue light spectrum. We evaluated chronotype, a characteristic that may relate to adaptation to light-at-night. Methods. We examined 1825 subjects (1129 population controls, 696 breast and prostate cancer incident cases; 919 men, 906 women) from Barcelona and Madrid, enrolled in 2008-2013. Indoor-ALAN information was obtained through questionnaires. Outdoor-ALAN was analyzed using images for 2012-2013 from the International Space Station (ISS) including data of remotely sensed upward light intensity and blue light spectrum information for each subject's geocoded longest residence. We examined excess-weight (BMI  $\geq 25$ ); abdominal-obesity (waist-hip ratio  $>0.85$  women,  $>0.90$  men) and overall obesity (WHR as above and BMI  $\geq 30$ ). ORs are adjusted for age, sex, education, center, case-control status and menopause (women). Results. Exposure to outdoor ALAN in blue light spectrum or visual light were not associated with measures of obesity (OR for highest tertile of blue light compared to lowest: 0.82 (95%CI 0.63,1.07) excess weight; OR=0.82 (0.60,1.13) abdominal obesity; OR=0.83 (0.61,1.13) overall obesity. ORs tended to be higher for subjects who slept in "quite illuminated" bedrooms compared to those sleeping in total darkness (excess weight OR=1.53 (0.98, 2.39); abdominal obesity OR=1.18 (0.68,2.03); total obesity OR= 1.36 (0.78,2.37). Results were similar when limited to controls and when mutually adjusting for indoor and outdoor light exposures. There was no effect modification by chronotype. Conclusion. Artificial light-at-night was not associated with excess weight or obesity.

### **P03.0430. Non-Occupational Noise-Induced Hearing Loss - an Emerging Epidemics: Current Status and Prevention Strategies**

Yulia Carroll

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Abstract: Noise is the most common preventable cause of hearing loss, the third most common chronic physical condition in the U.S. Sources of noise in the community and the numbers of those attending loud events, have increased in recent decades. As this preventable hearing loss often progresses insidiously for years before being self-perceived or diagnosed, it underscores the need for improving the availability of public health information for individuals and their healthcare providers. In early 2016 the Centers for Disease Control and Prevention (CDC) formed a small unfunded intra-agency workgroup to address the issues of non-occupational noise-induced hearing loss. The vision of this workgroup is to provide data and education, increase awareness and prevent noise-related hearing loss at home and in the community. We analyzed audiometric and health survey data from the National Health and Nutrition Examination Surveys (NHANES) 2007-2010 and 2011-2012. We estimated prevalence of audiometric notches as indicators for hearing damage. We found that 17% of US adolescents (12 to 19 years old) and 24% of US adults have audiometric notches. The presence of noise-induced hearing loss increased from one in five among young adults aged 20-29 years to one in four among adults aged 50-59 years. The prevalence rate of audiometric notches for females increased from 16% in the 2005-2006 survey to 20% in 2007-2010, and are now higher than in males. Almost one in four adults who reported excellent to good hearing already have measurable hearing loss. About 20 million American adults have hearing damage indicative of noise exposure that may likely be due to everyday activities in their home and community. Prevention steps include avoidance and keeping noise down, as well as using personal hearing protection devices. CDC is also encouraging primary care providers and other clinicians, especially those involved in primary care, to ask about difficulty with hearing as part of routine care.

**P03.0450. Indoor Environmental Factors and Influenza-Like Illness in Community Dwelling Older Population of Hong Kong: A Prospective Cohort Study**

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**Abstract:** Background: Previous studies have investigated the impacts of outdoor environmental factors (temperature, relative humidity (RH), absolute humidity (AH), rainfall) on seasonal variations of influenza virus activities. However, the findings were inconsistent to explain the circulation and summer surge of influenza in tropical and subtropical regions. We hypothesize that the controversial findings might be due to the lack of indoor environmental data. We conducted a prospective cohort study in community dwelling older people in Hong Kong to explore the relationship of indoor and outdoor environmental factors with incidence of influenza-like illness (ILI) in older people. Methods: A total of 231 older people aged 65+ years in the Hong Kong Island were recruited as index participants from Dec 2016 - Apr 2017. Automatic sensors were installed in the living room of each household to continuously collect the hourly indoor temperature and RH during the study period. The follow-up is still ongoing and expected to end by May 2019. Results: Here we report the preliminary findings of the first-year follow-up data from Dec 2016 - Mar 2018. Mean indoor temperature, RH and AH were 24.4°C, 68.1% and 22.2g/m<sup>3</sup> respectively. Indoor temperature and AH were highly correlated with outdoor temperature ( $r=0.95$ ) and AH ( $r=0.95$ ). While, indoor RH varied widely during June to September (difference  $10.8\% \pm 48.3$ ) and less correlated with outdoor RH ( $r=0.67$ ). The incidence rate of self-report influenza-like illness was 0.4 per person-year, and most were reported during May - Aug 2017 and Dec 2017 - Feb 2018. Preliminary results showed there was no significant difference between households with and without ILI cases, in terms of indoor environmental factors such as daily mean, minimum, median, maximum, variation of temperature, RH and AH. Discussion: Indoor-outdoor correlation was found high for temperature and AH but moderate for RH. Further analyses will be conducted when more data are collected.

### **P03.0460. Environmental Quality, Health and Learning in Conventional and High Performance School Buildings**

Stuart Batterman

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**Abstract:** Aims: Schools are critical indoor environments that can affect the health, comfort and performance of children and teachers alike. We discuss lessons learned in an intervention study of schools and highlight issues related to ventilation, filtration and outcomes assessments. Methods: We compare indoor environmental quality (IEQ) parameters in a 37 recently constructed or renovated elementary school buildings, balanced between high performance and conventional buildings located in the US Midwest. We then compare results of interventions designed to increase ventilation and particle filtration (from MERV8 to MERV13) using a case-crossover design and repeated measures involving 550 students and 2 schools. We report on attendance, cardiopulmonary fitness using the Progressive Aerobic Cardiovascular Endurance Run (PACER) test, and student learning. We also characterize IEQ parameters in four classrooms in each school, using multiday measurements. The buildings varied in design, HVAC system, size, and other factors. Only 22% of classrooms met recommended minimum ventilation rates. Occupancy in many classrooms was highly variable, thus, the use of carbon dioxide (CO<sub>2</sub>) concentrations as a tracer for determining ventilation rates should use the transient mass balance method. It was sometimes difficult to detect significant differences in air change rates when ventilation rates were increased, and improving filtration did not always lower particulate matter concentrations. We show that increasing ventilation with low efficiency filters can increase PM<sub>2.5</sub> levels. Students and teachers had positive experiences with the PACER test. Conclusion: Intervention studies have strengths and allow investigation of both IEQ and student performance. Interventions must be carefully selected to ensure meaningful exposure contrasts and yield meaningful epidemiological evidence.

### P03. Exposure Measurement, Modeling and Other Methodological Issues 3

#### **P03.0470. Generating Consistent Spatio-Temporal Events of Exposure for Translational Exposomic Research**

Ramkiran Gouripeddi

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**Abstract:** The concept of the exposome include endogenous processes within the body, biological responses of adaptation to environment, and socio-behavioral factors beyond assessment of exposures. Exposomes therefore need to cross-link locations and occurrences of environmental influences, and resulting direct biological pathway alterations as well as mutagenic and epigenetic changes on the phenome. Data representing these events need to be associated with their limitations and uncertainties associated with using the data as exact quantifications of exposure. In order to address these needs, we are developing a metadata-driven exposomic data integration platform, OpenFurther (OF), as a part of the Utah Pediatric Research using Integrated Sensor Monitoring Systems (PRISMS) Informatics Ecosystem (Grant NIH NIBIB U54EB021973). Based on the methods used for data collection (measurement or observation), and the differences and uncertainties in environmental measurements and true exposures, we grouped exposomic events into six broad categories: Sensor, Clinical, Biospecimen-derived, Participant reported, Aggregates, and Computational Models. Each of these events have spatio-temporal coordinates that can be unbounded, dense, discrete, instants & intervals, indeterminate, and at finest granularity available with the source. OF generates these event from heterogeneous study data and stores them as documents in Big Data stores. These high-resolution exposome records are used for spatio-temporal abstraction, reasoning and Big Data analytics methods. They can also be transformed with minimal transformational information loss into analytical models to support a diverse set of translational research archetypes including sensor development, environmental chemistry, exposure pathways, mechanistic understanding of environmental species on the genome for precision medicine, pharmacodynamics studies, clinical trials, observational, comparative effectiveness, and epidemiological studies.

### **P03.0480. Development of Analysis Method for Methanol in Detergent by GC-HS-MSD**

JeongSun Lee

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**Abstract:** Methanol is the simplest alcohol compound and is a colorless, volatile, flammable, and liquid with a distinctive odor very similar to that of ethanol (drinking alcohol). Methanol is converted into a substance called formaldehyde in the body at the time of absorption and is fatal to the human body. Methanol may be exposed to the human body by oral, transdermal and inhalation. Analytical methods of methanol in detergent have been previously reported, but the analysis was difficult due to the complicated steps by Ministry of Food and Drug Safety. Therefore it is needed to develop a method for analyzing the methanol content in dishwashing detergents that are commonly used in the home. The range of calibration curves were 0.1, 0.5, 1, 2, 5, 10, 20, 50 and 100 ng/mL. Detergent is generally viscous and not volatile. The sample was injected in GC-HS-MSD after diluted 10 times in water. This study was validated for 3 days. Standard solution were added to the detergent at each 7 samples for level of 1, 10, and 50 ng/ml. Accuracy, precision, linearity, and LOD (limited of detection) were calculated for the inter-day, and intra-day. The accuracy of the intra-day result were 98.2%~104% (inter), and 98.0%~111.3% (intra). The precision were less than 20%. The detection limit was calculated to be 0.24 ng/mL. The linearity obtained was satisfying for the methanol, with a coefficient of determination ( $r^2$ ) higher than 0.999. This method has simpler pretreatment steps and lower detection limit than existing analysis method. It could be used as a basic data for monitoring methanol content analysis of detergent.

### **P03.0490. Environmental Data in Longitudinal Epidemiology**

Joshua Vande Hey

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**Abstract:** The amount and diversity of data describing the natural environment are rapidly increasing. Accessing these data via record linkage provides excellent opportunities for environmental health research. However, there are varying research and data collection approaches across disciplines, as well as inconsistent awareness of established and emerging environmental data sources, their usefulness and their limitations. Based on experience of a multi-disciplinary team assessing impacts of air pollution in pregnancy and early life within the Avon Longitudinal Study of Parents and Children (ALSPAC) birth cohort located primarily in the city of Bristol in southwest England, we are developing practical guidance for identifying, assessing, selecting, combining, and linking environmental data to address questions in environmental epidemiology. **METHODS:** We mapped the data discovery, selection, and linkage process in air pollution exposure assessment for the ALSPAC cohort reported in Gulliver et al. (2018 Environ. Int.) and provided narrative on the process to highlight key steps and decisions that could inform translation to other cohorts. Multiple sources of data were searched, including national government and research datasets. We compared data extracted by Bristol City Council with local data discovered through an internet search. **RESULTS:** We found that while local sources of data vary considerably, there are key principles that can be applied to guide robust environmental epidemiology with an informed approach to dealing with uncertainty. We also found that evaluation of modelled exposures required local monitoring data only available from the city council. Critically, use of rich metadata and local knowledge meant some monitoring stations were found not to be representative and were not selected. **DISCUSSION:** We are developing an environmental data methodology that will inform epidemiological study design and analysis through dissemination to cohorts in the UK and internationally.

### **P03.0500. Exposure to Organophosphate Esters and Brominated Flame Retardants: What Does Your Cell Phone Tell You?**

Miriam Diamond

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**Abstract:** Background Widespread exposure to organophosphate esters (OPEs), used as flame retardants and plasticizers, is of concern due to emerging data on toxicity. We aimed to identify OPE concentrations and pathways of exposure to Canadian pre-menopausal women, and to compare that with brominated flame retardants (BFRs). Methods From 51 women in Toronto and Ottawa, we measured concentrations of OPEs in air and floor dust in their homes, and on their hands and their electronic devices. 557 samples were analyzed for 23 OPEs, 9 "novel" brominated flame retardants and 14 PBDE congeners. Also, urine samples from 44 participants were analyzed for 8 OPE metabolites. Results and Discussion OPE air and dust concentrations were in the low ng/m<sup>3</sup> and µg/g ranges, respectively, for 5-8 OPEs with >80% detection frequency. BFRs were ~100X lower. Eight OPEs also had >80% detection frequency on hands (up to µg/cm<sup>2</sup> levels) that were similar in samples taken 3 weeks apart. Handheld electronic devices (e.g., cell phone, tablet) had significantly higher OPE (but not BFR) concentrations than non-handheld devices (e.g., TV, desk top). OPE concentrations on hands were most frequently correlated with those on cell phones, whereas BFRs on hands were correlated with laptops. Moreover, we found a significant correlation between total ΣOPE concentrations on cell phones and those in the corresponding urine sample, driven mostly by Triphenyl Phosphate (TPhP). We also found a significant correlation between the parent compound TDCPP in dust and cell phones and the corresponding urinary metabolite. Only TCPP on hands was correlated with its urinary metabolite. Conclusions Our study confirmed widespread exposure to OPEs among Canadian women. We found that OPE exposure could in part be explained by levels found on a woman's cell phone and secondarily by concentrations in her residential floor dust and her hands. It is not clear whether the cell phones are acting as a source or indicator of exposure to OPEs.

### **P03.0510. Evaluation of Exposure to Perfluorinated Chemicals (PFCs) due to Contamination of Drinking Water in Gloucester County, New Jersey**

Clifford Weisel

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**Abstract:** Introduction: Perfluorinated chemicals (PFCs) are used in manufacturing stain resistant and water repellent consumer products and in firefighting foams at airports and military sites. They have been released into the environment inadvertently and when sprayed during firefighting scenarios and simulations. Due to their slow environmental degradation they have contaminated water supplies in multiple counties in the US potentially exposing more than 5 million people nationwide. The ground water in several communities in Gloucester County, NJ, particularly the municipal water in Paulsboro, was contaminated with perfluoro-n-nonanoic acid (PFNA) and perfluorooctanoic acid (PFOA). Since 2014, the water supplies have been filtered with activated charcoal. To assess the effectiveness of the water intervention program on reducing exposure to these PFCs, a convenience sample of 120 adult residents in the area have been recruited and twelve PFCs were measured in serum, household tap water, and household dust and a questionnaire administered as part of a CDC Biomonitoring grant. Results: The first visits have been completed and two more visits to each subject are planned approximately a year apart. Nine of the PFCs were routinely above the detection limits in the serum. The analyses of approximately half of the subjects have been completed, with the serum PFNA levels of the residents ( $5.9 \pm 9.5$ , median 3.3, maximum 60  $\mu\text{g/L}$ ) often exceeded the 95th% reported in the 2009-2010 NHANES levels for adults over 20 (3.94 (CI: 2.38-8.36)). The distribution of other PFCs serum levels were similar to that reported in NHANES. Water levels were below detection for all PFCs, indicative that the water intervention has effectively reduced the PFCs exposure through that route. PFCs were found in dust reflecting their use in consumer products. It is expected that the serum levels of PFNA will decline over the next few years if the drinking water was the main exposure source.

### **P03.0520. Recent Advancements in Method Development and Exposure Assessment for 45 Blood VOCs Analyzed by Headspace SPME GC-MS**

David Chambers

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**Abstract:** For over three decades our laboratory has been developing and improving methods for quantifying toxic volatile organic compounds (VOCs) in blood in support of numerous national and regional studies, including nine National Health and Nutrition Examination Survey (NHANES) cycles. Absorption of VOCs most commonly occurs through inhalation, as 100% of blood circulates to the lungs for exchange with alveolar gas. The high blood:gas partition ratios of most VOCs favor preconcentration in the blood, but blood VOC equilibration with tissues and organs is what influences VOC elimination half-life. As such, VOC analysis in blood is best-suited for compounds that are stable in the body by offering a direct measure of VOC burden experienced by tissues and organs. The current analysis method uses headspace solid-phase microextraction (HS-SPME) and gas chromatography-mass spectrometry (GC-MS). Important to the success of this method is the use of isotopically labeled analogs specific to every compound to compensate for competition effects in the headspace and SPME fiber, as well as adsorption and volatilization losses. The combination of these techniques has enabled us to simultaneously quantify a broad array of VOCs (boiling points from 32 to 204 °C) in the low parts-per-trillion (ng/L) range from a 3-mL blood sample. This presentation will include an overview of the blood VOC method and describe recent improvements to achieve accuracy and precision of < 15% for nonpolar compounds (e.g., alkanes) and within 5% for most of the other VOCs. We will also describe noteworthy blood VOC trends in the United States and reveal new analytes that are to be included in future studies and NHANES cycles. In addition to individual VOC trends, we will describe recent work comparing relative VOC levels among participants using artificial neural networks as a means to objectively distinguish exposure between different VOC sources within a large population.

### **P03.0530. Use of Public Water Supply Fluoride Concentration as an Indicator of Population Exposure to Fluoride in England 1995-2015**

Tony Fletcher

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Abstract: Studies of exposure to fluoride may use Geographic Information Systems to estimate population exposure by geo-referencing water supply zone (WSZ) monitoring data for public water supplies (PWS) to small areas. Geo-referenced fluoride PWS monitoring data were available from 2005-2015, but only non-referenced data from 1995-2004. We aimed to determine whether the geo-referenced fluoride concentrations in 2005-2015 could be used as a proxy for 1995-2004 population exposure. We also aimed to estimate population exposure to fluoride/fluoridation in PWS in England. We allocated annual average PWS fluoride concentrations and fluoridation scheme flagging data from national monitoring data to small areas using GIS. We obtained population data from routine data sources. Mean fluoride concentrations were estimated for each year in each WSZ (a 'zone-year'), for the two periods 1995-2004 and 2005-2015, stratified by fluoridation scheme-flagging. We compared the WSZ-level period means using Spearman correlation. For the geo-referenced data, we estimated spatial and population distribution of the period-average fluoride concentration. Almost all (97%) of the 16,188 zone-years of PWS monitoring observations were linked to WSZ boundaries for 2005-15, but only 8249/21553 (38%) pre-2005 zone-years were linked to their post 2005 WSZs. Grand mean 1995-2004 (0.11mg/l (SD 0.12)) and 2005-2015 (0.11mg/l (SD 0.12)) fluoride concentrations were similar, and WSZ-level means were highly correlated in un-fluoridated zones (Spearman correlation 0.93), but differed (1995-2004 0.74mg/l (SD 0.22), 2005-15 0.78mg/l (SD 0.16)) and correlated weakly in fluoridated zones (correlation 0.31). Most (72%) of the population received PWS with <0.2mg/l fluoride, 18% 0.2-<0.7mg/l, and 10% with ≥0.7mg/l. We estimated population exposure to fluoride in PWS across England in the period 1995-2015. Fluoride concentrations appear stable over time in WSZs, more clearly in zones without a fluoridation scheme.

### **P03.0540. Mapping Drinking Water Systems for Population Exposure Assessment**

John Minnery

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Abstract: Drinking water is a recognized pathway through which populations can be exposed to biological and chemical hazards. We mapped Ontario Municipal Drinking Water Distribution systems (DWDS) by matching census areas to images of drinking water pipe networks. The new maps enable ongoing epidemiological research and surveillance by allowing linkage of both drinking water monitoring data and administrative health data sets to the residence of the population served. The location of drinking water distribution pipes for systems serving a population of 5,000, or more, were obtained from the Ontario Ministry of Environment and Climate Change (MOECC). Images of pipe networks varied widely in resolution and detail, and were scaled and aligned by a GIS analyst using Google Earth and ArcMap v10.3. The smallest geographic areas for which Canadian census includes population, age and sex data i.e. "dissemination areas" (DAs) were used to approximate the boundaries of water systems. The selected DAs were spatially joined to form 153 polygons which include area home to 10,930,166 people (85% of the Ontario population). Each DWDS polygon has a unique MOECC identification number to enable patient address and health-data linkage to extensive water quality and treatment data. Population data from DAs were pooled within a DWDS to enable water-system level calculations of disease incidence and prevalence rates, standardized for age and sex. As census boundaries do not match those of DWDS, the maps created unavoidably include some error. This error can be quantified as the proportion of the Ontario population currently receiving drinking water from private systems erroneously assigned to a DWDS due to proximity. Methods to quantify this error are discussed, including the registry of private domestic wells which reveals error increasing as system size decreases. Analysis reveals that the error proportion can generally be limited to less than 10% for population areas of less than 13,000 people.

### **P03.0550. Exposure to Strontium through Drinking Water Used in the Preparation of Foods**

Lisa Melnyk

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Abstract: Strontium (Sr) is a natural element, ubiquitous in the environment and known to occur in water, food, air, and soils. Strontium is present in media as a salt or an ionized divalent cation. The Sr ion (dissociated) is toxicokinetically important because it is easily absorbed into systemic circulation when inhaled as particulates or ingested with water or foods. Identifying all routes of exposure to Sr is important for determining the relative source contribution (RSC). The RSC analysis is conducted to compare the estimated exposure expected in the general population from drinking water to exposure from intake of other media, including food. Ideally, a RSC analysis considers both the intake of a chemical from direct ingestion from tap water, as well as, contribution to the diet during preparation of foods when cooking with tap water and other sources. Research to determine the amount of Sr transferred from contaminated drinking water to individual foods during preparation was conducted. Strontium transferred to broccoli, lentils, and spaghetti at all levels tested (1.5, 10, and 50 mg/L) as evidenced by the residual Sr in the pour-off water following food preparation (33 - 64%). The data from the cooking study support the hypothesis that cooking of foods with water containing Sr adds to the total dietary Sr. A more comprehensive understanding of the contribution of water to dietary intakes through food preparation practices supports a more robust analysis of the tap water contribution to total daily dietary exposure. The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

### **P03.0560. Contaminants of Emerging Concern during De Facto Water Reuse**

Susan Glassmeyer

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**Abstract:** The drinking water and wastewater cycles are integrally linked. Chemicals that are present in household wastewater may be sufficiently mobile and recalcitrant to pass through on-site or municipal wastewater treatment and survive natural environmental removal processes. Such persistent compounds have the potential to reach surface and ground waters that may be a source of drinking water. The US Environmental Protection Agency and US Geological Survey are collaborating to examine the sources, fates, and potential effects of contaminants of emerging concern (CECs) during de facto water reuse which occurs when treated wastewater is discharged to a source of drinking water. The project sampling design follows a surface flow path, with the collection of grab water samples from upstream of a wastewater treatment plant outfall and downstream to a drinking water treatment plant intake and through the plant to a finished water sample. The study uses an integrated approach that includes a comprehensive analysis of over 200 specific chemicals (e.g. pharmaceuticals, per- and polyfluoroalkyl substances); high resolution mass spectrometry to identify non-targeted (unknown) chemicals; in vitro bioassays (e.g. estrogenicity, androgenicity); rapid whole organism screens to assess cumulative bioactivity; and in vivo tests to address specific exposure and response endpoints. A rigorous quality assurance/quality control protocol was consistently applied from field to laboratory to ensure comparability of results from different techniques. This consistent, integrated approach combines the strength of each technique and builds upon the traditional CEC research approach by including environmental and toxicity endpoint assessments to more fully explore the potential effects to human health and the environment from chemical exposures. This presentation will provide an overview of the study and results from the analysis for organic and inorganic chemicals from the samples.

### **P03.0570. The Transformation of Microcystin-LR during Tap Water Treatment Process**

Xinliang Ding

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**Abstract:** Objective To establish a liquid chromatography-tandem mass spectrometry (LC/MS/MS) method for the determination of microcystin-LR (MC-LR) in drinking water, investigate its removal efficiency during tap water advanced treatment process and analyze its degradation products in the tap water. Methods Water samples were collected from each point of tap water advanced treatment process and treated by mixing, filtration, concentration, elution, nitrogen blow and re-dissolvement. The samples were analyzed by LC/MS/MS to determine the MC-LR concentration and its removal efficiency during treatment process. The combination of actual water enrichment and laboratory simulated water were used to qualitative analyze the MC-LR degradation products by Orbitrap mass spectrometry. Results The linearity of MC-LR ranged from 2 µg/L to 200 µg/L with the detection limit of 0.0079 µg/L and the limit of quantification of 0.0263 µg/L. The recovery rate of MC-LR from different concentration in drinking water were from 94.88% to 101.47%. The intra-day precision was 2.51%-7.93% and the inter-day precision was 3.24%-8.41%. The average concentration of MC-LR in source water was 0.631 µg/L, 94.0% of which can be removed by ozone exposure, biological pre-treatment and chlorination. The remaining can hardly be removed by sand filtration, ozone exposure, activated carbon, ultrafiltration and other processes. The MC-LR average concentration in the finished water maintained at about 0.036 µg/L. Four degradation products were identified in the laboratory simulated water of the mixture of MC-LR and liquid chlorine in the mass ratio of 1:10. Conclusion the established MC-LR detection method can be well applied to the monitoring of MC-LR in drinking water due to its simple pre-treatment process and good methodological validation parameters. The removal efficiency of treatment processes was different.

## **P03.0590. Bridging Observational Studies and Randomized Experiments by Embedding the Former in the Latter**

Marie-Abele Bind

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Abstract: Consider a statistical analysis that draws causal inferences from an observational dataset, inferences that are presented as being valid in the frequentist senses; i.e., the analysis produces: 1) consistent point estimates, 2) valid p-values, valid in the sense of rejecting true null hypotheses at the nominal level or less often, and/or 3) confidence intervals, which are presented as having at least their nominal coverage for their estimands. For the hypothetical validity of these statements, the analysis must embed the observational study in a hypothetical randomized experiment that created the observed data, or a subset of that hypothetical randomized data set. This multistage effort with thought-provoking tasks involves: 1) a purely conceptual stage that precisely formulate the causal question in terms of a hypothetical randomized experiment where the exposure is assigned to units; 2) a design stage that approximates a randomized experiment before any outcome data are observed, 3) a statistical analysis stage comparing the outcomes of interest in the exposed and non-exposed units of the hypothetical randomized experiment, and 4) a summary stage providing conclusions about statistical evidence for the sizes of possible causal effects. Stages 2 and 3 may rely on modern computing to implement the effort, whereas Stage 1 demands careful scientific argumentation to make the embedding plausible to scientific readers of the proffered statistical analysis. Otherwise, the resulting analysis is vulnerable to criticism for being simply a presentation of scientifically meaningless arithmetic calculations. The conceptually most demanding tasks are often the most scientifically interesting to the dedicated researcher and readers of the resulting statistical analyses. This perspective is rarely implemented with any rigor, for example, completely eschewing the first stage.

## **P03.0600. Neonicotinoids in Honey Bee Produced in Jalisco, Mexico: Analysis of Environmental and Human Exposure**

Gilda Ponce-Vejar

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**Abstract:** Neonicotinoids (NN) have been used worldwide, since 1990's as a novel insecticide. There is scientific evidence of environmental affectation, due to its systemic and persistent action. Use of NN indicates that plants translocate it into their pollen, nectar and fruits. Because these compounds cannot be washed away, NN has been detected in our food system and human body. In Mexico there are 7 NN government's approved for domestic use, for use in pets, forestry, corps and livestock. Jalisco is an important Mexican states in food production, to include bee honey production, which has seen a 15% decline in the last years. It is suspected that NN have played a role in this decline. A lack of scientific studies regarding the use of NN's on the environment and the particular effects on humans creates a critical need in Mexico for further assessment. In the pilot, and follow-up study, honey is used as an indicator of surrounding environmental quality determining residual levels of NN. **Method:** During the pilot and follow-up study, based on land uses, honey samples were collected from 30 different Jalisco locations during 1 harvesting season. Samples were analyzed via an LC-MS/MS multi-residue screen for NN concentration at ng/gr in the Agriculture and Food Laboratory from Guelph University. **Results:** Pilot study found pesticide (NN and organophosphates) residues in honey and wax. This indicates that the beehives, larvae and bees have been exposed to pesticides. 30 additional samples were analyzed in order to identify NN at ng/gr. Honey's residue level of NN results were compared with EU LMR Codex Alimentarius in order to describe environmental and human exposure based on in vivo/vitro recent studies. **Conclusion:** This study improves our understanding about the NN environmental and human exposure through honey. We identified that the different levels of NN concentrations are related with land uses and the food produced in each region (e.g., avocado, corn, berries,).

**P03.0610. National Estimation of Seafood Consumption in Mexico: Implications for Exposure to Methylmercury and Polyunsaturated Fatty Acids**

Alejandra Cantoral

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Abstract: Background: Seafood is a good source of Omega-3 polyunsaturated fatty acids (w3-PUFA) but also contains the toxic contaminant methylmercury (MeHg). National estimates of exposure to both compounds through seafood intake in Mexico are not known. The objective of the current study was to describe national seafood consumption habits and to estimate seafood-based exposure to w3-PUFAs and MeHg. Methods: We analyzed data from a 24-h dietary recall extracted from the 2012 National Health and Nutrition Survey of Mexico (n= 10,096 subjects aged 1y and older). National per capita seafood intake, as well as information on age, sex, socioeconomic status, and geographic region was obtained. The contribution of each seafood item to the total MeHg exposure was estimated, as was the balance between estimated exposures to w3-PUFAs and MeHg. Results: A mean daily seafood intake of 10 g/day was estimated. The top species consumed in decreasing order were: canned tuna, sunfish, shrimp, mullet, carp and schoolshark (constituted 60% of seafood intake). Canned tuna and schoolshark contributed 75% of the population's estimated exposure to MeHg. The best balance of population-level exposures to w3-PUFAs and MeHg was found in salmon, sardine, trout and anchovies. Conclusion: Environmental dietary exposure to MeHg is a public health concern and thus a good understanding of seafood consumption is needed to create national consumption guidelines. The current study provides nationally-representative data in Mexico from which decisions can be made and future studies conducted.

### **P03.0630. Determination of Perfluorinated Compounds Level of Domestic and Imported Crabs in South Korea**

HeeDeuk Yang

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Abstract: Perfluorinated compounds(PFCs) are an organic fluorine compound that hydrogens of all of carbons compound were replaced by fluorine. PFCs were demonstrated for toxic effects by various studies. PFCs tend to accumulate because of the long half-life in vivo. Research on PFCs level of food material in South Korea is still in insufficient. In this study, we analyzed 19 PFCs in crab meat with LC-MSMS. A total of 151 crabs were collected from fish market of South Korea. The samples taken included countries of origin information; South Korea (n=104), China (n=37) and India (n=10). Crab samples were homogenized with water. Each sample was weighed (1g) and spiked 20 µl internal standard. PFCs were extracted from samples using ion-pairing extraction after enzyme hydrolysis. Quantitative analysis was performed with liquid chromatography-tandem mass spectrometry(LC-MS/MS). As result, PFOA was detected in South Korean and Chinese crab samples. PFTrDA and PFDS levels were higher in Chinese crab than South Korean Crabs. Although the legal criteria of PFCs in food is not yet defined, the levels of PFCs in South Korean crabs were similar to or less than other studies performed in aboard; Belgium (PFOS ranged from 93 to 292 ppb), China (PFOS up to 82.2 ppb) and Japan (PFOA ranged from 5.6 to 14 ppb).

### **P03.0640. Determinations of Triclosan and Parabens in Household Dusts by Solid-Phase Microextraction with Microwave Assisted Extraction**

Shih-Wei Tsai

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Abstract: Indoor dust has been known as a sink for many semi-volatile organic compounds, such as triclosan and parabens. Since indoor environment can protect dust from sunlight, rain and biological degradation, pollutants then could be persistent and accumulated in the residential environment. Up to now, the analysis of triclosan and parabens in dust is solvent and time consuming. Therefore, a method for the measurement of triclosan and parabens in dusts simultaneously by using microwave assisted direct-immersion solid-phase microextraction (MAE-DI-SPME) has been developed to determine the distributions in Taiwan. In this study, commercial vacuum cleaner was used to collect household dusts while particles with diameter smaller than 150 $\mu$ m were filtered out by stainless mesh. Afterwards, 0.02g dust sample was spiked with 2.5  $\mu$ g/g of surrogate in a 4mL vial and stood for overnight. RO water of 2.5mL was added into the sample the next day, followed by the filtration and MAE-DI-SPME extraction procedures. Gas chromatograph-tandem mass spectrometer (GC/MS/MS) was employed for the analysis. Several parameters affecting the SPME extraction efficiency were optimized. The results showed that the desorption efficiency was 100% when the desorption time was 20 min under 250 degree C. The best suitable fiber coating was 65 $\mu$ m PDMS/DVB and the optimum condition of MAE-DI-SPME for extraction of triclosan and parabens in dust was 20 minutes at 80 degree C. For indoor dust samples in Taiwan, the median, mean and range of triclosan and parabens concentrations were determined, respectively. Relatively to headspace extraction, the established method of MAE-DI-SPME for the measurements of triclosan and parabens in indoor dust provides good linearity and precisions. Besides, compared with traditional extraction methods, the MAE-DI-SPME provides a time saving, easy for operation and solvent-free procedure.

## **P03.0650. Investigation of Factors Associated with Measurements of Personal Light (Including UV) Exposure Levels**

Yuji Nishiwaki

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**Abstract:** Background/Aim Although concerns over the effects of light (including ultraviolet [UV] light) exposure on health are growing, accurate estimation of personal light exposure levels is difficult, because they are affected by many factors. We used a novel mobile sensing device to measure personal light exposure. Measurements taken under varying conditions were compared: 1. subjects' behaviour, 2. time, 3. weather, and 4. location of the device. In this session, we report our measurements of UV exposure. Methods Light exposure was measured for 5 volunteers in a series of 15-minute periods on a total of 24 days in the same park in Kanagawa Prefecture, Japan. Measurements were taken under different conditions for comparison. First, measurements taken when the subjects were under no behavioural restriction were compared with those taken when certain behaviours were dictated. Second, measurements were taken at different times of day: At solar noon, 2 hours before, and 2 hours after. Third, measurements taken under 4 different levels of cloud cover were compared. And fourth, comparisons were made according to which part of the body the devices were attached to: The face, shoulder, chest, wrist, or leg. Results Levels of personal UV irradiance were not affected by subjects' behaviour or by time of day. However, they were affected by device location, with the highest levels measured at the shoulder; levels decreased in the following order: chest, wrist, face, and leg. Levels also decreased according to the extent of cloud cover. Conclusions Our findings suggest that weather conditions and device location are significant factors in personal UV exposure level measurements. We are planning to use our findings to carry out an epidemiological study on the association between UV exposure and serum vitamin D concentrations in Japanese subjects.

### **P03.0660. Selecting the Best Method among Several: Bayesian and Classical Data Analyses Comparison in a Complex Microbiological Validation Setting**

Yvette Bonvalot

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Abstract: Statistical procedures to compare new methods to gold standards, after validation of microbiological food methods, exist. However, evaluation of the best microbiological detection method among several is more challenging; there is little precedent in scientific literature. Our work compares Bayesian hierarchical (BH), Bayesian logistic Anova-like (BL-AL) and Classical logistic (CL) models using an original validation study, based on Health Canada's Microbiological Methods Committee guidelines. The validation study design includes 6 microbiological methods, 13 food panels of 20 samples each, and 10 laboratories, and theoretically generates 780 sub-groups, reduced to 198 after quality review. In classical statistics this would lead to 231 null hypothesis tests, requiring significance level ( $\alpha$ ) correction for multiple comparisons. Assuming non-informative priors, BH and BL-AL estimations include meaningful parameters (e.g. method detection rate (DR), DR differences between methods, etc.), reallocate their credibility based on observed data, and provide posterior distributions and 95% high credibility intervals (HCrI). Joining HCrI with pre-defined Regions of Practical Equivalence (ROPEs) allows for null hypotheses decision making: rejection, acceptance, or no decision. BH and BL-AL give similar results and posteriors. Posteriors' modes are nearly identical to best-estimates computed with CL. Statistical conclusions will be similar between BH, BL-AL and CL if, and only if, significance level ( $\alpha$ ) is corrected for multiple comparisons. Nevertheless only Bayesian allows null hypotheses acceptance and a clean ranking of the 6 microbiological methods using posterior densities within, below, and above ROPE limits. Using flat priors, it isn't surprising to find similarities between Bayesian and Classical methods. However, while avoiding classical paradigm misinterpretation issues, the Bayesian framework provides informative and meaningful results with no multiple comparison issues.

### **P03.0680. Patterns of E-Cigarette Use and Health Characteristics of E-Cigarette Users in Baltimore County**

Atul Aravindakshan

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**Abstract:** Introduction: E-cigarettes have gained popularity among the youth with peak initiation risk at 14-15 years, and as a tool to combat tobacco addiction. Current scientific literature indicates that e-cigarettes are less harmful when compared to traditional cigarettes. However, emitted e-cigarette aerosol contains known toxins such as formaldehyde, toxic metals, and nicotine. Aim: To characterize vaping preferences and health characteristics of e-cigarette users in Baltimore County, USA Methods: 53 e-cigarette users and 50 non-users were recruited from Baltimore county. Information about demographics, patterns of e-cigarette use, other smoking habits, and dental and physical health were collected through questionnaires. Results: Majority of e-cigarette users were Caucasian (87%), male (72%) with a mean age of 28 years, and had consistently used e-cigarettes for a little less than 3 years. 85% of users reported the need to vape within the first hour of waking up, with 28% feeling the need within the first 5 minutes. The mean nicotine concentration of e-cigarette juice used was 6.5 mg/ml. Participants vaped an average of 45 ml of e-cigarette fluid per week and used a mean voltage setting of 4V. 50% of users intended to reduce nicotine concentration, and 51% planned to quit the use of e-cigarettes altogether. A preference for higher nicotine concentration with increase in age was observed; 0.37 mg/ml CI: (0.20,0.53) in the unadjusted model and 0.40 mg/ml CI: (0.22,0.57) when adjusted for sex, education level, race and smoking status. There was a higher prevalence of hypertension (21% vs 4%), history of wheezing (17% vs 2%), and shortness of breath (28% vs 12%) in e-cigarette users compared to non-users. There were no significant differences in other health characteristics reported. Conclusion: Our study describes patterns of e-cigarette use in Baltimore county, USA. Further research is required to understand the health effects of e-cigarette use.

## **P03.0690. Applying Low-Cost Sensors for Personal Particulate Matter and Noise Exposure Assessment**

Eelco Kuijpers

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Abstract: Low-cost sensors offer the possibility to gain more insight into personal exposure. Compared to traditional methods, sensors provide more high resolution data in space and time. However, there is a gap in understanding how these devices perform and how they can be applied for actual prevention. The overall aim of this study was to examine the accuracy and precision of low-cost sensors for particulate matter (PM) and noise and to study their field application. Two different low-cost PM (OPC-N2, Alphasense; SDL607, Nova Fitness) and two low-cost noise sensors (Rion NL-27; Noise Sentry) were compared (concordance correlation coefficient (ccc)) to reference devices and relatively calibrated. Next, the low-cost sensors were deployed to measure personal exposure of construction, roadside and desk workers. In addition, observations and questionnaires were used to obtain contextual information. The OPC-N2 was strongly correlated for PM<sub>2.5</sub> (average ccc=0.78) while the SDL607 (data per 5 minutes) showed moderate correlations (average ccc=0.43) compared to a reference device. The field measurement demonstrated that construction workers had the highest exposure of PM<sub>2.5</sub> (N=5, median=13.68 µg/m<sup>3</sup>) compared to roadside (N=6, median=2.19 µg/m<sup>3</sup>) and desk workers (N=4, median=0.09 µg/m<sup>3</sup>). Average noise exposure varied between 62-79 dB and 74-87 dB for the Rion NL-27 and Noise Sentry, respectively. Furthermore, peaks in exposure for noise and PM 2.5 could be explained based on contextual information. In conclusion, the tested PM<sub>2.5</sub> and noise sensors showed rather accurate and precise results at least within sensor types, which could subsequently be used for real time prevention of high exposures. These sensor results highlight their importance of sensor technology as a promising tool with respect to the exposome concept aiming to measure the totality of a person's lifetime exposure.

**P03.0700. An Air Quality Modeling System Providing Smoke Impact Forecasts for Health Protection in Southeastern U.S.A.**

Armistead Russell

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**Abstract:** Background/Aim Prescribed fire is the leading source of PM<sub>2.5</sub> emissions in southeastern USA. We are developing the HiRes-X modeling system to forecast prescribed fire activity and its impacts on air quality and human health, and the Southern Integrated Prescribed Fire Information System (SIPFIS) to disseminate these forecasts, along with measures of social vulnerability and health impacts, for emergency planning and preparedness purposes. Methods HiRes-X uses innovative modeling and machine learning approaches to identify areas most impacted by prescribed fires. Specifically, a regression tree model is built using meteorology and prescribed fire data from recent years to generate highly resolved burn activity forecasts. Burn emissions are calculated using satellite enhanced fuel maps, consumption estimates and region specific emission factors. Community Multiscale Air Quality model is used to compute the contribution of burn emissions to local and regional air quality. HiRes-X modeling system is integrated with measures of cardiorespiratory health impacts and social vulnerability to identify communities vulnerable to smoke from prescribed fires. SIPFIS dashboard provides map and chart visualization tools that are built using open source software, and it features interactive capabilities to respond dynamically to user selections. Results Analyses that can be performed with SIPFIS include comparisons of burn activity forecast to burn permit records or satellite fire detections, and air quality forecast to observations. SIPFIS can be used for planning prescribed burning operations to reduce human exposure to fire smoke. Conclusions HiRes-X forecasting system incorporates new elements that can facilitate dynamic management of prescribed fires in southeastern USA. SIPFIS dashboard offers various analysis features that can be used to take preventive actions for minimizing the air quality and health impacts while reaping the ecological and economic benefits of prescribed burning.

### **P03.0710. Exploring the Use of Robots for Exposure Studies**

Elisabeth Cook

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**Abstract:** Robots are becoming more incorporated into our society to perform routine tasks in research and the workforce. The attractive qualities of using robots include consistency, repetition, and longevity. This proof-of-concept study aimed to determine if robots are suitable to use for exposure predictions, by comparing the data to published human air painting data and/or model estimates, and to investigate the volatile organic compound (VOC) exposure from painting on drywall. A 2-arm smart robot was programmed to paint drywall for an average of  $64 \pm 11$  minutes in a controlled environmental facility. Temperature and relative humidity were kept constant at  $25 \pm 0.47$  °C and  $40 \pm 6$  %, respectively, to ensure uniform conditions and to control/measure the air exchange rate throughout the study. During the robotic painting session, the off-gassing of VOCs from paint was measured for both personal and area zones. VOC measurements were taken using passive and active air samplers, and direct-read monitors. Consistent results for the area painted for the front ( $60.1 \pm 2.5$  cm by  $77.5 \pm 0.85$  cm) and sides ( $60.1 \pm 2.5$  cm by  $60.1 \pm 2.9$  cm) and the amount of paint used per trial ( $1.53 \pm 0.65$  kg) suggest that using a robot to perform an exposure study was successful. Branched alkanes, acetone, and isopropanol were among the VOCs with the highest concentration detected in the active air samplers. For the resulting VOC concentrations, a direct correlation between amount of paint used and the total hydrocarbon concentration was observed. The average total hydrocarbon concentration measured was  $1.44 \pm 0.39$  ppm. The direct-read monitors followed the same trend at higher observed VOC concentrations of  $2.74 \pm 0.94$  ppm (right),  $1.74 \pm 0.56$  ppm (middle), and  $2.15 \pm 0.9$  ppm (left), compared to the total hydrocarbon measurements. Overall, a low VOC concentration ( $< 3$  ppm) was found indicating a low exposure for personal and area zones.

**P03.0720. Practical Aspects for Implementing Low Burden Particulate Matter Samplers in a Pediatric Cohort Asthma Intervention Study**

Maria Tchong-French

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**Abstract:** An academic-community partnership is currently working on an intervention study (Home Air in Agriculture Pediatric Intervention - HAPI) to examine the effectiveness of High Efficiency Particulate Air (HEPA) cleaners to improve children health with asthma in a rural agricultural setting. We measured particulate matter (PM) concentrations (PM<sub>2.5</sub>, PM<sub>10</sub>) in indoor air before and after the implementation of the HEPA cleaners in the homes. We selected the RTI International MicroPEM (MP) samplers for measuring PM<sub>2.5</sub> and PM<sub>10</sub> concentrations due to their low subject burden (size/noise), low relative cost, and ease of use by community partners for field sampling (calibration/operational procedures). Implementing the MP samplers, originally personal monitors, into stationary monitors in low income homes with children, many with limited space presented practical challenges. We developed a low cost, readily mobile and "child proof" minimal profile sampler stand utilizing an intravenous pole with hooks that held a bird suet feeder. The MPs were placed inside the feeder. The stand provided an opportunity to hang other passive samplers (Ogawa) used in the study. Sporadic incomplete PM sampling by the MPs during our 2 week integrated sampling period were investigated through subject and field staff interviews and iSocket 3G power outage monitoring. We discerned child contact with on/off buttons and unplugging the devices explained most data loss. Simply placing lab tape over MP buttons and additional training for families has resulted in more complete sampling. Preliminary data from subjects with sampling conducted before and after HEPA air cleaner assignment demonstrate effectiveness in PM for intervention homes (% change) compared with control homes (%).

## **P03.0730. Patterns of Monthly Variation in Urban Ambient Nitrogen Dioxide Observed in a National Monitoring Network, Plus Implications for Exposure Assessment**

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Abstract: Assessment of exposure to traffic-related air pollution (TRAP) is often based upon an observational campaign using a network of passive samplers, using nitrogen dioxide as a proxy for TRAP. These data are then frequently used as the input for a land-use regression model. However, such observational campaigns are frequently limited in time - in some cases only a single sample - and therefore the stability of the spatial variation observed in time is assumed. The New Zealand Transport Agency established a national monitoring network for NO<sub>2</sub> in 2007, with coverage expanded to over 120 sites in 2010. Passive samplers have been deployed at these sites every month for over a decade, allowing temporal patterns, and variation in patterns between sites, to be investigated. Analysis has revealed that all sites possess a persistent seasonal variation with concentrations peaking in winter and reaching a minimum in summer. The seasonal variation is more predictable at urban background sites with the amplitude of seasonal variation being proportional to the annual mean concentration. However, at sites close to major roads, intersections and within street canyons, seasonal variation is less in amplitude, but also subject to more random variation making it less predictable. Attempts to cluster sites using site metadata to predict differences in temporal variation were generally unsuccessful indicating either true randomness, or the absence of critical explanatory variables in the available metadata. Some sites revealed step-changes at certain points in time which may be related to step-changes in local traffic flows. A seasonal adjustment algorithm was created to predict annual mean concentrations based on sub-annual observational campaigns. The relationship between the length of a hypothetical short observational campaign and the error in the adjustment (and hence predicted annual mean concentration) as a function of site metadata was characterised.

### **P03.0740. How Far Are We from Having Air Quality in Navigation Apps?**

Qiang Yang

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Abstract: Checking traffic using navigation apps has become the norm when we plan routes for car trips. A real-time air quality model with high spatial resolution built into route selecting navigation apps could greatly benefit people doing outdoor exercise or frequent commuting, in addition to the EPA's Air Quality Index (AQI) forecast (<https://www.airnow.gov/>) that uses data from federal reference or equivalent monitoring techniques typically at rather coarse spatial resolution, e.g. 10 sites in NYC. This real-time high-resolution air quality model is the long-term goal of the Map My Air project (<https://project.wnyc.org/map-my-air/>). In this pilot study, output of seasonal spatial surface of fine particulate matter (PM<sub>2.5</sub>) from a land use regression model based on bi-weekly data from the New York City Community Air Survey (originally 150 monitoring sites, now ~70) adjusted by hourly temporal variation provided from AirNow PM<sub>2.5</sub> levels is compared to 3-years of data collected by personal air monitors (RTI microPEM and Aethlabs microAeth AE51) from biking commuters in NYC at 1-minute and approximately 300 m resolution. Model outputs show a median PM<sub>2.5</sub> concentration of 11.6 µg/m<sup>3</sup>, a good agreement with personal monitor observation data of 11.7 µg/m<sup>3</sup>, but show a much smaller range of predicted PM<sub>2.5</sub> (6.6 - 21.5 µg/m<sup>3</sup>, IQR 10.1 - 13.4 µg/m<sup>3</sup>) in comparison to that of observation (0.5 - 710 µg/m<sup>3</sup>, IQR 7.7 - 18.1 µg/m<sup>3</sup>) and a very weak correlation with observation data due to the inherent incapability of this simple model in predicting extreme values. Real-time traffic data and meteorology data will be added together with the personal air monitor observation data to refine the model's spatial resolution to street level and improve its temporal sensitivity to sub-hour level.

### **P03.0750. Exposure to Fine Particles and PAHs in Pizza Restaurants with Wood-Fired Ovens**

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**Abstract:** Introduction Some restaurants use wood-fired ovens for cooking and baking, e.g. pizzerias. The aim was to measure exposure to fine particles for the workers and in the restaurants. Methods Measurements were performed at seven restaurants (2 days, 8 hr). The ovens were located in a working area in the restaurants. Personal exposure to fine particles (PM<sub>2.5</sub>) and particulate polycyclic aromatic hydrocarbons (PAHs) were measured on two workers at each restaurant. PM<sub>2.5</sub> was collected on teflon filter. Mass concentration was determined gravimetrically and analyzed for PAHs using GC-MS in SIR mode. One of the workers also wore a personal sampler for black carbon (BC), MicroAeth Model AE51. Stationary sampling equipment were placed near the oven and near the dining tables. In addition, size-fractionated particle samples (five size ranges including >2.5, 1.0-2.5, 0.50-1.0, 0.25-0.50, and < 0.25 µm) were collected near the oven using a Sioutas Cascade Impactor. Particle number concentration (PNC), 10-1000 nm, was measured with a Condensation Particle Counter (CPC3007). Results Median personal exposure to PM<sub>2.5</sub> and B(a)P for 26 workers were 27 µg/m<sup>3</sup> (range: 13-76 µg/m<sup>3</sup>) and 0.13 ng/m<sup>3</sup> (range: 0.01-2.6 ng/m<sup>3</sup>), respectively. Stationary levels were similar to personal exposure. No significant difference was found between concentrations near the ovens and the dining area. The majority of the B(a)P (>95%) was found in the two finer stages (0.25-0.50, and <0.25 µm). Out of that, in average 78% was found in the finest stage. Median BC exposure varied between 0.5 and 4.1 µg/m<sup>3</sup> and was higher during lunch and evening rush hours. The PNC varied across a wide range between the restaurants, with means from about 20 000 up to 170 000 part/cm<sup>3</sup>. Conclusions The exposure to B(a)P were well below OEL. Almost all B(a)P was associated with PM<sub>0.25</sub>. Particles generated from the wood-fired ovens gave rise to high number concentrations; however, the measured particles mass concentrations were low.

**P03.0760. The Impacts of Energy-Efficient Interventions on Population Health, Indoor Environmental Health, and Energy Costs: A Simulation Study of Multifamily Housing**

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**Abstract:** **BACKGROUND.** Residential energy-efficiency measures such as weatherization and ventilation improvements can have important impacts on direct energy utilization, resident health outcomes associated with indoor air quality (IAQ), and general population health influenced by ambient air quality. The development of flexible, analytical tools to examine the potential trade-offs among these impacts is essential for the identification of retrofits that are energy-saving and health protective, yet no study to date has modeled all three of these dimensions together. **METHODS.** We estimated the impacts of energy and ventilation retrofits in a set of typical gas-heated midrise multifamily buildings in the U.S. using a combination of 1) novel IAQ-energy co-simulation modeling (CONTAM/EnergyPlus), 2) energy-to-emissions modeling for power plants (AVERT) and residential combustion, 3) fine particulate matter (PM<sub>2.5</sub>) health impact assessment using co-simulation IAQ outputs and regional-scale atmospheric dispersion model (CMAQ-DDM) outputs, and 4) health outcome monetization. **DISCUSSION.** Interventions that combined weatherization and ventilation measures provided energy savings, resident health benefits, and general population health benefits that varied by intervention type, performance level, season, and location. General population health benefits were approximately 8% of direct economic savings and the ratio between population health benefits and economic savings was approximately 1.5 to 3 times greater for electricity than for residential combustion. Interventions without ventilation improvements led to increases in indoor PM<sub>2.5</sub> and associated monetized indoor environmental health disbenefits that greatly outweighed direct energy savings and population health benefits. Results emphasize the importance of holistic energy-efficient interventions that explicitly consider IAQ and our analytical framework can be used to inform health-protective residential energy-efficiency policy.

### **P03.0770. The Sky's the Limit: 3D Air Pollution Sensing Using Drones**

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Abstract: Current air quality monitoring networks rely on stationary sites, which do not effectively capture transient and localized pollutants such as methane leakage and anthropogenic volatile organic compounds (VOCs). Drones carry the potential to transform how communities, regulators and industry quantify emissions and air quality impacts. Air quality monitoring using drones addresses two fundamental challenges: 1) the inability to monitor directly at source and in the vertical plane, and 2) real-time, 3D pollutant dispersion tracking. While these dynamic systems can provide novel data streams; they intrinsically cannot be as specified, controlled, or reproducible as traditional methods. Therefore well-defined data interpretation approaches and substantial data quality assurances are needed. Here we present system architecture, functionality, technical challenges, legal aspects, and quality assurances related to a multi-air pollutant sensing drone platform. System architecture encompasses the drone, the multi-air pollutant module (MAPM), and communication data links. The MAPM is equipped with active measures of carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) using Alphasense B4 sensors. In response to sensor limitations, a remotely controlled grab sampling protocol was developed with up to eight remotely controlled 0.2L sample bags for post-hoc chemical analyses (VOCs, and methane). To support pollutant-tracking and grab-sample source apportionment capabilities, real-time wind speed and direction algorithms were developed by reverse engineering on-board telemetry diagnostics (e.g., pitch, yaw, and roll). As drone technology continues to mature alongside real-time gas sensing technologies, these techniques can complement traditional methods of stationary-site air quality monitoring. Over time we anticipate aerial air quality monitoring to overcome intrinsic limitations and play a significant role in shaping the future of air quality and exposure assessment.

## **P03.0780. Mobile-Monitoring of Air Pollution (Black Carbon): Preliminary Results from Bangalore, India**

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**Abstract:** INTRODUCTION India is home to some of the world's most polluted cities. Stationary monitoring generally does not provide information about local variations in air pollution concentrations. We conducted a pilot study in Bangalore, India to explore the potential for mobile monitoring to provide high-resolution exposure data in Indian cities. METHODS Our aim is to over-sample a small area, thereby shedding light on the how many mobile-monitoring measurements are needed to get a robust estimate of concentrations at each location. We conducted measurements using a motorcycle equipped with an aethalometer for black carbon (BC). Our study area includes mixed income neighbourhoods and an adjoining highway, with a total riding distance of ~45 km per day. Roads include small streets and alleys in each neighborhood. Raw BC measurements were corrected for two common measurement artifacts. RESULTS To date, we have collected 20 h of repeated measurements. The overall median BC concentration on all roadways was 16  $\mu\text{g}/\text{m}^3$  (highways vs. surface streets: 67 vs. 15  $\mu\text{g}/\text{m}^3$ ). Preliminary results suggest that the initial dataset is sufficient to obtain robust estimates of spatial variability in concentrations. Planned additional monitoring will help confirm that finding for the study location and for additional neighborhoods.

**P03.0790. Development of Air-Bot Samplers: Community Networks of Inexpensive Sensors as Sentinels to Trigger Air-Sampling Methods**

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Abstract: Air-Bots are automated samplers with inexpensive sensors that find hotspots in which to sample. The Air-Bots use Wi-Fi/Bluetooth-capable microcontrollers capable of turning on sampling pumps or opening and closing evacuated canisters. The sensors are semi-quantitative, allowing for the mapping of relative hotspots. Community residents can permit Air-Bots to use their Wi-Fi to report the data. Should the network identify a hotspot, the closest Air-Bot will start a sampler and report that sampling has begun -for us to pick up to analyze. The Air-Bot network reduces the number of samples compared to monitors with threshold value triggers only. The continual data reporting allows us to abort some sampling because the event is too short-lived to warrant laboratory analysis. They allow for data reporting in-between investigations and are inexpensive enough to leave behind. We developed two teams of Air-Bots, odor-based and particulate-based. The odor-based Air-Bot teams use calibrated ammonia and hydrogen sulfide sensors linked to a solenoid atop an evacuated canister. They currently capture grab samples to identify the chemicals associated with elevated odor events. Another design is to locate the sensor close to the source of pollution with the sampler at a downwind residence. The particulate-based Air-Bots use optical sensors chosen for specific situations. They are linked to a personal sampling pump and filter for particulate analysis. One sensor is well-suited to trigger respirable quartz samples. The network can retain and map real-time data from multiple Air-Bots. Data from each Air-Bot can be re-animated to identify events that need further processing. Air-Bot sensor data correlate well measurements. The continuous stream of data helps identify movement of PM plumes while the quartz measurements are to compare with health-based time-weighted averages.

### **P03.0800. Evaluation of Two Low-Cost PM Monitors (Dylos and Speck) Against Dusttrak DRX for Monitoring Urban PM Concentrations in Astana, Kazakhstan and Tehran, Iran**

Aigerim Makso

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**Abstract:** Since the availability of low-cost monitors, researchers have investigated possible correlations with low-cost PM monitors and respective well referenced high-cost monitors. In the present study two low cost instruments were used to examine the air quality. A Dylos DC1700 (a low-cost equipment), and a Speck (Specksensor). Dylos monitors the particle number concentrations in two sizes, larger than 0.5  $\mu\text{m}$  (hereinafter called small size) and larger than 2.5  $\mu\text{m}$  (hereinafter called larger size). Speck provides PM<sub>2.5</sub> mass concentration. A DustTrak DRX Model, TSI, USA was employed to measure PM mass concentrations (PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>4</sub>, PM<sub>10</sub>, Total particles). We have evaluated Dylos and Speck against Dusttrak DRX individually for different indoor and outdoor sources. Three PM sources including mixed grilling (ground beef meat), construction particles, and outdoor PM in a rural area, Borovoye, Kazakhstan, and smoking particles at Middle East Technical University Northern Cyprus Campus were examined to evaluate the performance of Dylos against Dusttrak. For Mixed Grilling and Construction source, the correlation coefficient values for fine and coarse fractions were found to be 0.61 and 0.66, respectively. This moderate correlation could be due to the presence of significant amount of coarse size particles that can be detected by Dylos. Combining all smoking data, poor correlation values for fine ( $R^2 = 0.17$ ) and coarse ( $R^2 = 0.20$ ) particles were obtained. Poor correlation coefficient values were observed for both fine ( $4 \times 10^{-5}$ ) and coarse ( $6.1 \times 10^{-3}$ ) particles during the monitoring of outdoor PM in Borovoye. Speck was compared with Dusttrak DRX for commuting PM in Astana city. We are now analyzing the data. For ISES 2018, we are aimed to evaluate the performance of these two low-cost PM monitors against DustTrak DRX by running the monitors in Tehran, Iran for three weeks during May 2018 and in Astana, Kazakhstan for 8 weeks during June-August 2018.

### **P03.0820. The Source Identification of Indoor Fine Particulate Matter Based on Infiltration Factor of Beijing Residence**

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**Abstract:** Objective To quantify the contribution of ambient and indoor-generated PM<sub>2.5</sub> to indoor air in residential environments in Beijing, and to explore the influencing factors of indoor-generated PM<sub>2.5</sub>. Methods A total of 55 residents in Beijing were selected. The indoor and outdoor PM<sub>2.5</sub> were monitored in both non-heating (n=43) and heating seasons (n=45) for 7 consecutive days. The mass concentrations of PM<sub>2.5</sub> were measured by gravimetric method, while elemental concentrations of sulfur in filter deposits were determined by energy-dispersive X-ray fluorescence spectrometry. PM<sub>2.5</sub> infiltration factor was estimated as the indoor/outdoor sulfur ratio. The concentrations of ambient and indoor-generated PM<sub>2.5</sub> were calculated according to mass balance equation. The questionnaire was used to collect the general characteristics of the residences and the indoor activities of the occupants. Multiple linear regression model was used to explore the influencing factors of indoor-generated PM<sub>2.5</sub>. Results In both seasons, the majority of indoor PM<sub>2.5</sub> was of ambient origin [81%±21% (Median=83%) in non-heating season and 75%±24% (Median=77%) in heating season], and the seasonal differences were not statistically significant (P=0.230). Indoor generated PM<sub>2.5</sub> concentrations in non-heating season were 12.8±16.4µg/m<sup>3</sup> (M=8.4µg/m<sup>3</sup>) which were slightly lower than the responding values 22.2±32.9µg/m<sup>3</sup> (M=10.4µg/m<sup>3</sup>) in heating season (P=0.226). During non-heating season, indoor smoking and hours of window opening were associated with indoor generated PM<sub>2.5</sub>, which can explain the 27% of total variations across residences, while the indoor smoking was the only factor identified in multiple regression model during heating season, which could explain 25% of total variations across residences. Conclusion the indoor PM<sub>2.5</sub> levels in residents of Beijing are mainly from outdoor air. Reducing indoor smoking and increasing window ventilation can effectively reduce the exposure to indoor-generated PM<sub>2.5</sub>.

**P03.0830. The IVAIRE Study: Inter- and Intra-Seasonal Variations in VOC's Measured in Canadian Homes with Asthmatic Children during a Intervention Field Study**

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**Abstract:** A randomized intervention study was done to measure the impact of improved ventilation on indoor air quality (IAQ) and the respiratory health of asthmatic children in Québec City. The intervention involved the installation of a Heat or Energy Recovery Ventilator while a comprehensive suite of environmental parameters were used to characterize the IAQ. The IAQ measurements were taken during three separate periods both before and after the intervention. The winter measurements, used to correlate ventilation rates with IAQ and respiratory health, were taken twice to account for intra-seasonal variations in IAQ while the single summer measurement was taken to determine the inter-seasonal variations. A cohort of 111 asthmatic children were enrolled for the pre-intervention phase of which 83 were selected to participate in the subsequent intervention phase because their homes were found to be under-ventilated (air exchange rate <0.30 h<sup>-1</sup>). The children were then randomized into an intervention (n=43) and control (n=40) group for the second year (post-intervention phase) of the study. This paper presents the variations in the VOC's measured within the same season, between seasons (winter, summer), along with the year-over-year variations within the same season. A statistically significant seasonal variability was observed for relative humidity, NO<sub>2</sub>, VOC's and aldehydes. The aromatic and aliphatic hydrocarbons were most elevated in winter, up to 2x higher, and were the most strongly impacted by the ventilation intervention. The aldehydes, oxygenated VOC's, and NO<sub>2</sub>, all had higher summertime concentrations despite the median air exchange rate being almost twice as high during summer. A possible explanation could be that the increased temperature and humidity encountered in summer would promote the release of aldehydes from hydrolysis reactions and off-gassing from construction and consumer products and that ambient formaldehyde is generally higher in summer.

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#### **P03.0860. Prenatal Particulate Air Pollution and the Incidence of Childhood Cancers: Identifying Critical Windows and Differences by Regional Oxidative Potential**

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**Abstract:** Background: Studies have reported associations between prenatal exposure to fine particulate air pollution (PM<sub>2.5</sub>) and the incidence of early childhood cancers. However, few studies have examined specific windows of vulnerability and possible effect modification by PM<sub>2.5</sub> oxidative potential. The aim of this study was to identify sensitive windows for the effects of PM<sub>2.5</sub> on childhood cancer development and whether regional differences in the oxidative potential of PM<sub>2.5</sub> modified the associations. Methods: Our cohort consisted of ~1.5M singleton live births occurring between 1998 and 2015 in 31 cities in the province of Ontario, Canada. PM<sub>2.5</sub> from ground monitors were collected and city-level PM<sub>2.5</sub> oxidative potential were measured. Incident cases of specific paediatric cancers among children up to age 6 were ascertained through administrative health data linkages. Using distributed lag models (DLMs), we examined associations between weekly averaged PM<sub>2.5</sub> levels over pregnancy and childhood cancer incidence. We used random effects meta-analysis to combine the estimates of effect from regression models across cities on childhood cancer incidence and used meta-regression to evaluate the modifying effect of PM<sub>2.5</sub> oxidative potential. Results: We identified 1,644 incident childhood cancer cases. An interquartile increase (2.6 µg/m<sup>3</sup>) in PM<sub>2.5</sub> levels at weeks 4-13 were positively associated with an increased risk of astrocytoma in the highest quartile of glutathione-related oxidative potential (OR = 1.34; 95% CI: 1.15, 1.51), but not the lowest quartile (OR = 0.99; 95% CI: 0.81, 1.22; p-interaction = 0.03). We did not observe associations for other cancer types. Between-city differences in ascorbate related oxidative potential did not significantly modify associations of cancer subtypes with PM<sub>2.5</sub>. Conclusions: Between-city differences in glutathione-related oxidative potential may modify the impact of PM<sub>2.5</sub> on the risk of a specific type of brain tumor in children.

**P03.0870. Annual Average PM2.5 Exposure Is Associated with Mortality in a Heart Failure Cohort: Results from the EPA CARES Study**

Cavin Ward-Caviness

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Abstract: As part of the EPA CARES study, we extracted electronic health records (EHRs) on 41,000 heart failure (HF) patients seen at a University of North Carolina affiliated hospital from 01/01/2004 through 12/31/2016. After data cleaning and restricting to those residing in North Carolina we were left with a study cohort of 37,206 individuals. Over an average follow-up time of 2.25 years (83,895 person-years total follow-up time), we observed 9690 (26.0%) natural cause (non-accidental, non-homicidal) deaths. Information on annual average PM2.5 exposure was taken from ground-based monitors operated by the Environmental Protection Agency. Cox proportional hazards models were used to model the association between natural cause mortality and PM2.5 exposure while adjusting for age, sex, race, Hispanic ethnicity, the distance to the nearest monitor, and neighborhood characteristics. Results are given in terms of the hazard ratio (HR) per 1 µg/m<sup>3</sup> increase in PM2.5 and the associated 95% confidence interval (CI). In CARES, annual average PM2.5 exposure was associated with a substantial elevated mortality risk (HR = 1.24, CI = 1.23, 1.26); results which were consistent when restricting to those within 30 km of a monitoring station (HR = 1.22, CI = 1.21, 1.24). This association was strongest in those with diagnosed HF before the age of 50 (HR = 1.31, CI = 1.26, 1.36). As compared to individuals residing in areas below the National Ambient Air Quality Standard of 12 µg/m<sup>3</sup> for PM2.5, individuals in areas exceeding 12 µg/m<sup>3</sup> had an elevated mortality risk (HR = 2.72, CI = 2.60, 2.86). Long-term PM2.5 exposure is associated with a substantial mortality risk in individuals with pre-existing HF, particularly those diagnosed before age 50. Residing in areas with annual average PM2.5 above 12 µg/m<sup>3</sup> may impart substantial mortality risk for those with HF as compared to residing in areas below this level. This abstract does not necessarily reflect the policies of the U.S. EPA

### **P03.0880. Long-Term NO<sub>2</sub> Exposures and Cause-Specific Mortality in American Older Adults**

Ki-Do Eum

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**Abstract:** The impact of long-term exposure to nitrogen dioxide (NO<sub>2</sub>) on all-cause mortality and cause-specific mortality is poorly understood. We examined the association between long-term NO<sub>2</sub> exposure and cause-specific mortality among about 14 million Medicare beneficiaries living close to US Environmental Protection Agency air quality monitoring sites in the conterminous US from 2000 to 2008. After controlling for age, gender, race, and state, we found significant positive associations between 12-month NO<sub>2</sub> exposure and all-cause mortality [Hazard Ratio (HR): 1.06; 95%CI: 1.06, 1.06; per 10 ppb]. Additionally, long-term NO<sub>2</sub> exposure was associated with the three most common causes of death: mortality from cardiovascular (1.14; 95%CI: 1.14, 1.14) and respiratory disease (1.05; 95%CI: 1.04, 1.06) and from cancer (1.02; 95%CI: 1.02, 1.02). Twelve-month moving average NO<sub>2</sub> exposure was also associated with increased mortality from ischemic heart disease (1.22; 95%CI: 1.18, 1.20), cerebrovascular disease (1.10; 95%CI: 1.10, 1.10), and pneumonia (1.24; 95%CI: 1.24, 1.25). As expected, NO<sub>2</sub> was not positively associated with accidental mortality risk. When we additionally adjusted for county level behavioral variables (using the BRFSS data), we found similar patterns of association. When we extended our analysis to the 64 million beneficiaries living in the conterminous US from 2000 to 2008 as a sensitivity analysis, we similarly found association between long-term NO<sub>2</sub> exposure-associated mortality from all-cause, and cause-specific mortality. In our large cohort of U.S. Medicare beneficiaries, we provide additional evidence of the increased risk posed by long-term NO<sub>2</sub> exposures on mortality from all-causes, cardiovascular and respiratory disease, and cancer and provide new evidence of the impact of long-term NO<sub>2</sub> exposure on pneumonia.

**P03.0890. Evaluation of a Method to Indirectly Adjust for Unmeasured Covariates in Large Administrative Data Cohort Analyses: An Analysis of Associations between Fine Particulate Matter and Mortality in the 2001 Canadian Census Health and Environment Cohort (2001 C**

Anders Erickson

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**Abstract:** Background. The method of indirect adjustment for unmeasured confounding is a promising technique in large cohort studies, however no formal evaluation of non-linear survival models has been conducted. Objectives: To describe and evaluate the indirect adjustment method for air pollution -mortality relationships with a large longitudinal cohort, the 2001 Canadian Census Health and Environment Cohort (CanCHEC, N=2.4 million), and a representative matching dataset (pooled cycles of the Canadian Community Health Survey, [CCHS], N=450,000) with detailed behavioural risk factor information. Methods: We compared the distribution of exposure to fine particulate matter (PM<sub>2.5</sub>) among subjects across multiple characteristics (age, sex, etc.), and examined the direction and magnitude of correlations amongst variables common to both datasets. We assessed the performance of indirect adjustment on non-linear Cox proportional hazard models by comparing estimates in the CanCHEC with and without indirect adjustment for known variables. Further, we estimated the degree of bias correction by removing variables available in both the CCHS and CanCHEC (e.g. education, income) and evaluated differences. Results: At baseline PM<sub>2.5</sub> distribution profiles across population characteristics were similar in both cohorts. PM<sub>2.5</sub> levels for CCHS participants tended to consistently be 1.8-2.0 µg/m<sup>3</sup> lower than the CanCHEC cohort, likely due to sampling differences between urban and rural areas since applying a sample-weighting scheme to the CCHS largely corrected for this discrepancy. Initial non-linear validation tests indicate possible underestimation of the PM<sub>2.5</sub> association with further testing on-going. Conclusions: Formal evaluation using a large longitudinal mortality cohort and representative health survey will help establish protocols that other jurisdictions can use to assess the viability of the indirect adjustment method when information on potential confounding variables are not available.

**P03.0900. Spatiotemporal Continuous Estimates of PM2.5 Concentrations in China, 2000-2016: A Machine Learning Method with Inputs from Satellites, Chemical Transport Model, and Ground Observations**

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**Abstract:** Background: Exposure to ambient PM2.5 is known to harm public health in China. Satellite aerosol optical depth (AOD) were statistically associated with in-situ observations after 2013 to predict PM2.5, while the lack of monitoring data before 2013 created difficulties in historical estimates. Hindcast approaches using chemical transport models (CTM) can overcome this limitation, but still suffer incomplete coverage due to missing AOD or limited accuracy due to uncertainties of CTM. Objects: We attempted to produce historical PM2.5 estimates with complete spatiotemporal coverage and improved accuracy for exposure assessments in short- and long-term. Methods: First, we designed a machine learning (ML) model, which linked in-situ PM2.5 with high-dimensional expansion of numerous predictors (AOD, CTM outputs and etc.). To interpolate the missing predictions due to incomplete AOD, we incorporated another generalized additive model in next stage. Results: Cross-validations show that ML estimates were highly correlated with in-situ PM2.5, with R2 of 0.61, 0.68, and 0.75 for daily, monthly and annual averages, respectively. The two-stage estimates sacrificed accuracy on daily timescale (R2=0.55), but achieved complete spatiotemporal coverage and improved the accuracy of monthly (R2=0.71) and annual (R2=0.77) averages. The model was used to predict daily PM2.5 across China during 2000-2016 and estimate long-term trends for the period. The population-weighted PM2.5 significantly increased, by 2.10 (95% confidence interval [CI]: 1.74, 2.46)  $\mu\text{g}/\text{m}^3/\text{year}$  during 2000-2007, and rapidly decreased by 4.51 (3.12, 5.90)  $\mu\text{g}/\text{m}^3/\text{year}$  during 2013-2016. Conclusions: The data products could support large-scale epidemiological studies and risk assessments of PM2.5 in China.

### **P03.0910. Prevalence of Lung Function Abnormalities Following the Fort McMurray Wildfires**

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**Abstract:** Air pollution contributes significant to the burden of respiratory diseases. Vehicular, industrial and increasingly, wildfire emissions are major sources of air pollution in Canada. Increased symptoms, hospitalizations and mortality immediately after wildfires are known; the long-term health impact have not been studied. The devastating 2016 Fort McMurray (FMM) wildfires forced the months-long evacuation of the entire town and destroyed many homes. Most residents returned several months later, choosing to stay and rebuild. The long-term health impact of wildfires, and the ongoing exposure to resuspended residual wildfire ash are not known. Our study aims to assess the long-term impact on lung health in the permanent residents of FMM. We report on the health status of the first 45 participants (26F, 19M; mean age=45±2 yrs, range 21-71 yrs) at 18 months after the onset of the fires. Target enrolment is 200 with follow-up of at least 5 years. All 45 are permanent residents (mean residency=16±12; range 3-46 yrs). 13 worked in the oils sands; 5 are current smokers and 18 ex-smokers. Spirometry revealed a higher than expected prevalence of airflow obstruction; 11% had an FEV1 (forced expiratory volume in 1 sec)/FVC (forced vital capacity) ratio 1/FVC1/FVC<72.5%. 31% reported intermittent cough±sputum. Two had childhood asthma; only one is treated with inhaled steroids. One participant had COPD, treated with inhaled bronchodilators. The cohort was generally healthy with only 4 participants reporting underlying medical diseases other than lung disease. They were, however, obese with mean BMI=31±1. Our preliminary analyses found a higher than anticipated burden of unrecognized lung disease. Development of disease in this generally healthy young population will have significant social and public health impact in Canada.

## **P03.0920. An Analysis of Critical Air Quality Episodes in Santiago, Chile: Episode Prediction Modeling and Benefit-Cost Analysis**

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**Abstract:** In January 2017, the United States Environmental Protection Agency (USEPA) and Chilean Ministry of Environment (MMA) launched the Megacities Partnership to advance air quality management in the Santiago metropolitan region. A goal of this partnership is to assess the effectiveness of MMA's critical episode management system, which restricts polluting activities in anticipation of air quality 'episodes', or days when PM<sub>2.5</sub> concentrations are forecasted to be above a certain threshold concentration. Each day during Chilean winter, MMA must predict whether the next day's PM<sub>2.5</sub> concentrations will exceed a threshold concentration for an episode to be declared. The MMA uses monitored air quality, modeled air quality, and meteorological data to predict episode status for the next day and recommends to the local government whether to initiate PM<sub>2.5</sub> emissions mitigation policies. We created logistic regression models using data available to the MMA team at the time the recommendations are made to understand which set of variables best predicts an air quality episode. We found that maximum monitored PM<sub>2.5</sub> concentration in the region, wind speed, specific humidity, the temperature differential between high and low elevation points in the city, and separately modeled air quality predictions (using WrfChem or Meteodata) are predictive variables that should be considered by the MMA episode declaration team. We also calculate health-related economic benefits and costs associated with instituting these emissions mitigation measures using EPA's BenMAP-CE model. We find that the mortality and morbidity-related economic benefits associated with declaring an episode offset the industrial, residential, and transportation costs of implementing the episode.

### **P03.0930. Hourly Associations between Ischemic Cardiac Events and Ambient Particulate Air Pollution: Does the Geographical Origin of the Particles Matter?**

Ronit Nirel

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**Abstract:** Introduction. Most of the studies linking cardiovascular disease with particulate matter (PM) exposures have focused on particle size and mass concentration. However, it has been increasingly recognized that it is important to also consider chemical composition. Examining the paths of air masses can provide insight into particle composition. The geographical location of Israel makes it susceptible to PM transport from distinct and diverse sources, thus making it an ideal place for back-trajectory analyses. We hypothesized that the air mass origin modifies the association between hourly PM exposure and acute ischemic events. Methods. Using telemedicine data, we conducted a case-crossover study of 1,855 confirmed ischemic cardiac events in Tel Aviv and Haifa, Israel (2005-2013). Ambient PM<sub>2.5</sub> and PM<sub>10-2.5</sub> concentrations during the hours before event onset were compared with matched control periods. We calculated 72-hr back-trajectories and divided them into 12 classes by their geographical origin and season. Results. Overall we found a 1.013 (95% confidence interval (CI): 0.981-1.046) and 1.003 (95% CI: 0.994-1.013) increased odds of an ischemic event for a 10 µg/m<sup>3</sup> increase in the 6-hr average of PM<sub>2.5</sub> and PM<sub>10-2.5</sub> respectively. The associations for PM<sub>2.5</sub> were strongest for air masses originating from Sinai and Egypt, with respective 1.29 (95% CI: 1.14-1.46) and 1.28 (95% CI: 1.08-1.52) greater odds for an ischemic event per 10 µg/m<sup>3</sup> increase in the previous 6 hours. For PM<sub>10-2.5</sub> the estimates were largest for air masses arriving from Europe on summer days (odds ratio (OR)=1.48, 95% CI: 1.09-2.02) and for Arabian Desert trajectories (OR= 1.07, 95% CI: 1.02-1.13) for the 6-hr averages. Conclusions. Our study suggests that sub-daily associations between PM and ischemic cardiac events are modified by the geographical origins of the particles. These findings may be translated to warnings of the population using e.g. available information on synoptic systems.

## **P03.0960. Traffic Density and Mortality Risk in the 1991 Canadian Census Health and Environment Cohort (CanCHEC)**

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**Abstract:** Background: There is evidence that local traffic density and living near major roads can adversely affect health outcomes. We aimed to assess the relationship between local road length, proximity to primary highways, and cause-specific mortality in the 1991 Canadian Census Health and Environment Cohort (CanCHEC). Methods: In this long-term study of 2.6 million people, based on completion of the long-form Census in 1991 and followed up until 2011, we used annual residential addresses to determine the total length of local roads within 200 m of centroid of postal codes, and the subject's distance to primary highways. The association between exposure to traffic and cause-specific mortality was estimated using Cox proportional hazards models, adjusting for individual covariates and contextual factors, including census division-level proportion in high school, the percentage of recent immigrants, and neighborhood income. We performed sensitivity analyses, including adjustment for exposure to PM<sub>2.5</sub>, restricted to subjects in core urban areas, and spatial variation by climatic zone. Results The hazard ratio (HR) for all non-accidental mortality associated with an interquartile increase in length of local roads was 1.05 (95% CI 1.04, 1.05); and for an interquartile range increase in proximity to primary highways, 1.03 (95% CI 1.02, 1.04). However, HRs by traffic quartile increased with increasing lengths of local roads, or closer proximity to primary highways, for all mortality causes. The associations were stronger in subject residing in urban core areas, attenuated by adjustment for PM<sub>2.5</sub>, and HRs showed limited spatial variation by climatic zone. Conclusion: In the CanCHEC cohort, exposure to greater road density and proximity to major traffic roads were associated with increased mortality risk from cerebrovascular and cardiovascular disease, ischemic heart disease, COPD, respiratory disease, lung cancer, and with unclear results for diabetes.

**P03.0970. Air Pollutants and Incidence of All-Cause, Lung, and Bladder Cancer in the Gazel Cohort (1989-2014)**

Emeline Lequy-Flahault

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**Abstract:** Background/Aim While air pollutants - fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>) and black carbon (BC) - are associated with mortality, their association with cancer incidence remains unclear. We aimed to analyze the relationships between these pollutants and the incidence of all-cause, lung and bladder cancer in the French general population-based cohort Gazel. Methods Land use regression models with back-extrapolation were used to assess the long-term exposure to PM<sub>2.5</sub>, NO<sub>2</sub>, O<sub>3</sub> and BC at home addresses of 19,530 participants, as the average exposure between enrolment and cancer incidence or censoring, whichever came first, with a 10-year lag to account for the time between initial exposure and the development of cancer. Follow-up was from 1989 to 2014. We used Cox models to derive hazard ratios (HR) for an interquartile range (IQR) increase of single pollutant exposure, adjusted for lifestyle and socioeconomic individual covariables at baseline including gender and occupational exposures, and with age as the underlying time scale. Results We found significant associations between PM<sub>2.5</sub> (IQR 7 µg/m<sup>3</sup>) and incident all-cause and lung cancer with respective HR of 1.15 (CI 1.10-1.21) and 2.08 (1.76-2.45); between NO<sub>2</sub> (IQR 21 µg/m<sup>3</sup>) and all-cause and lung cancer with respective HR of 1.05 (1.01-1.10) and 1.32 (1.11-1.57); between BC (IQR 1 µg/m<sup>3</sup>) and all-cause and lung cancer with respective HR of 1.05 (1.01-1.09) and 1.43 (1.23-1.66). No significant association was found between O<sub>3</sub> and incident cancers, nor between any pollutant and bladder cancer. Conclusions PM<sub>2.5</sub>, NO<sub>2</sub> and BC are associated with incidence of all-cause and specifically lung cancer in a general population-based cohort.

### **P03.0980. Elevated Particulate Matter and Noise Exposure for Spectators at Outdoor Motorsport Events**

Ben Greenfield

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Abstract: Since the first recorded steam carriage race in Manchester England, in 1867, motorsport racing has been a globally popular and commercially successful leisure activity. Enthusiasts enjoy a wide range of events, including Formula, stock car, motocross, drag, and many other styles. Despite the many environmental health hazards present at racing events, there have been no published exposure assessment studies for event spectators. To address this knowledge gap, we conducted noise and particulate matter exposure assessment at a series of auto and motocross racing events. Sampling was conducted from May to October, 2017 in designated spectator seating areas at two dirt auto racing tracks, a paved auto racing track, and a dirt motocross track in the St. Louis metro-east region, Illinois, USA, and in Sedalia, Missouri, USA. Using a TSI Instruments SidePak AM520 personal aerosol monitor, arithmetic mean PM<sub>2.5</sub> concentration ranged from 51 to 86  $\mu\text{g m}^{-3}$  across eight race events. Using a Digi-Sense portable sound meter, arithmetic mean noise levels ranged from 75 to 92 dB, and maximum noise levels ranged from 85 to 105 dB across nine race events. PM<sub>2.5</sub> at individual race events was combined with 24 hr average concentration data from Illinois EPA's Granite City, IL ambient air monitoring sites to obtain time weighted average estimated 24 hour PM<sub>2.5</sub> exposure for race spectators. Based on these calculations, 24 hour PM<sub>2.5</sub> for race spectators would be 1.8 to 3.5 times local background exposure. These values corresponded to EPA Air Quality Index levels of 63 to 92, falling in the Moderate category, which presents potential respiratory symptoms to highly sensitive individuals. Planned future data collection includes gravimetric sampling, and particle composition analyses. Our results suggest that despite the short duration of these activities, there are possible respiratory hazards from airborne particulate matter exposure for spectators with preexisting vulnerability.

### **P03.0990. Change in Fine Particle-Related Premature Deaths among Vulnerable and Susceptible Population Subgroups in the U.S. between 1980 and 2010**

Neal Fann

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Abstract: As levels of air pollution such as fine particles (PM<sub>2.5</sub>) have declined over time, so has the burden to public health. A large body of literature has examined the change over time in the recent and historical public health burden of common air pollutants including PM<sub>2.5</sub> in the United States (US). These studies have reported aggregate cases of deaths and illnesses attributed to PM<sub>2.5</sub>, but less is known about how changes in air pollution levels over time have impacted vulnerable and susceptible population subgroups. In this analysis, we draw upon the results of an air quality prediction model that estimates historical changes PM<sub>2.5</sub> between 1980 and 2010 across all counties in the contiguous U.S. For the year 1980, we define groups of vulnerable and susceptible populations according to attributes including county-level educational attainment, income, urbanicity, and all-cause death rate. Using a health impact function, we quantify PM<sub>2.5</sub>-attributable premature deaths for 1980 and 2010 among the overall U.S. population as well as these subgroups. Then we used the Atkinson Index to explore the inequality in the absolute level and change in PM<sub>2.5</sub> mortality among and between subgroups. Between 1980 and 2010, total PM<sub>2.5</sub> mortality risk declined for all groups. Risk inequality, as measured by the Atkinson Index and Gini coefficient, fell across all population groups and the risk experienced among each vulnerable and susceptible group becomes more equitably distributed. These results suggest that falling ambient PM<sub>2.5</sub> concentrations over a 30-year period yield significant benefits among populations most susceptible and vulnerable to poor air quality. Furthermore, our results imply that policy regulations such as the Clean Air Act are effective at reducing health disparities.

### **P03.1000. Air Pollution Mortality Risk and Socioeconomic Status in the Canadian Census Health and Environment Cohort**

Amanda Pappin

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**Abstract:** Background: Social inequalities in air pollution exposure and associated health burdens have been documented in the literature for decades. Materially and socially disadvantaged groups tend to have higher exposures to air pollution and may be more susceptible due to co-occurrence of other stressors, barriers in access to health care, etc. Better characterization of air pollution impacts by socioeconomic status (SES) is needed to inform strategies for mitigating risks in vulnerable populations. Methods: We examine the relationships between SES, fine particulate matter (PM<sub>2.5</sub>) exposure, and risk of mortality in a population-based Canadian cohort, the Canadian Census Health and Environment Cohort (CanCHEC). We run Cox proportional hazards models over a 10.6-year period and using 1 km resolution PM<sub>2.5</sub> estimates to evaluate whether individual level SES modifies the association between PM<sub>2.5</sub> and non-accidental mortality. Our analyses are adjusted for income adequacy, education, ethnicity, marital status, and neighborhood level SES. We will extend our final analysis to include nitrogen dioxide (NO<sub>2</sub>) and ozone. Results: Our preliminary results indicate that PM<sub>2.5</sub> exposure levels are highest among visible minorities, persons with low income adequacy, and persons who are university educated. We further find that educational attainment, income adequacy, marital status, and employment status significantly modify the association between PM<sub>2.5</sub> and mortality risk. Associations between PM<sub>2.5</sub> and mortality are stronger among: persons without a university education, persons with low income adequacy, and visible minorities. These trends are robust to adjustment for other SES indicators. Conclusions: Our findings indicate that air pollution risks vary significantly by SES, even in a population with universal access to health care, and that air pollution reduction strategies that prioritize environmental equity can benefit from more refined risk estimates for affected populations.

### **P03.1010. Chronic PM2.5 Exposure and Lipids/Lipoproteins among Midlife Women**

Xiangmei Wu

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Abstract: Fine particles (PM2.5) are known to increase risks of cardiovascular diseases, but very few studies have examined impact of long-term PM2.5 exposure on plasma lipid. In this study, we examined the association between PM2.5 exposure and lipid/lipoprotein among 2289 midlife women from six sites across U.S. between 1999 and 2005 (average 49±3 years old at the first visit included), and explored potential vulnerable subgroups. PM2.5 data were obtained from the U.S. Environmental Protection Agency monitoring network. The average prior one-year exposure was calculated and assigned to each woman based on proximity of the monitors to her residential address. Mixed effects models were used to account for repeated measures for each woman, adjusted for site, race/ethnicity, education, and time-varying variables including age at the visit, visit number, menopausal status, body mass index (BMI), smoking status, alcohol use in the past 24 hours, hormone use, and non-work activity level. The changes in lipids/lipoproteins presented different patterns by dyslipidemia status, menopausal status, and BMI categories. With increased PM2.5 exposure, increased atherogenic lipoproteins, such as, Apolipoprotein (Apo) B and lipoprotein(a), were observed in women without dyslipidemia and women with BMI less than 25, e.g., 5.0% (95%th CIs: 0.8%, 9.4%) and 6.1% (1.1%, 11.3%) increases in ApoB in these two groups, respectively, per 10 µg/m<sup>3</sup> increase of one-year average PM2.5 exposure. Reduced protective lipoproteins, including ApoA1 and lipoprotein A1, were observed in women with dyslipidemia and overweight (25≤BMI<30) and obese (BMI≥30) women. Both trends were observed in peri-menopausal women (had a period within the past 11 months but became irregular). These results suggested that chronic PM2.5 exposure was adversely associated with lipid levels through different mechanisms in midlife women, and all lead to increased cardiovascular risks.

### **P03.1020. Association between Changes in Air Pollution Levels and Airway Inflammation in Healthy Young Adults**

Bin Han

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**Abstract:** Background: The associations between short-term exposure to fine particulate matter and airway inflammation factors are still not well understood in healthy young adults. Objectives: To determine whether FeNO (Fractional exhaled nitric oxide, the maker of airway inflammation) is sensitive to changes in ambient PM<sub>2.5</sub> concentration. Methods: We measured FeNO data in 67 healthy young college students every season during last three years (Nov. 2014 to Jan 2018), and collected urban PM<sub>2.5</sub> daily concentration data through our study periods. Linear mixed-effect models was used to evaluate the change in FeNO measurement during different season and year under different PM<sub>2.5</sub> pollution level. Results: PM<sub>2.5</sub> concentration showed evident seasonal variation during past three years, except the winter in 2018. Because of strict control on air pollution in studying area, low concentration of PM<sub>2.5</sub> was observed in the winter. Correspondingly, the mean value of FeNO measurements in this winter was significantly lower than that in previous seasons, indicating low PM<sub>2.5</sub> concentrations would lead to the attenuation of the airway inflammation. Model results showed that interquartile range increase in PM<sub>2.5</sub> concentrations was associated with increases in the FeNO measurement (38%, 95%CI: -4%-81%). Conclusion: PM<sub>2.5</sub> exposures are associated with increased level of airway inflammation.

### **P03.1030. Personal Exposure to PM2.5, Black Carbon and Carbon Monoxide and Their Effects on Atherosclerosis: A Cross Sectional Assessment in Bangladesh**

Muhammad Ashique Haider Chowdhury

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**Abstract:** About 40% of the world's population are exposed to hazardous particles from biomass fuel use at households. Effects of such exposures on preclinical markers of cardiovascular diseases (CVD) are practically challenging to measure and mostly unexplored in low- and middle-income countries. GEOHealth study is examining the effect of individual level exposures to PM 2.5, black carbon (BC) and carbon monoxide (CO) on atherosclerosis among 600 biomass fuel users in rural Bangladesh. We are measuring PM 2.5 by gravimetric method using personal air samplers (RTI MicroPEMT). BC is being determined by reflectance measurement using an EEL-type smoke stain Reflectometer. CO is measured by Lasker EL-USB CO data logger. We assessed Carotid intima thickness (cIMT), a marker of atherosclerosis, using the SonoSite MicroMaxx ultrasound machine equipped with a L38e/10-5 MHz transducer. We are using the mean of the near and far walls of the maximum common carotid artery (CCA) IMT from both sides of the neck as the outcome variable. Structured questionnaire is used to record important co-variables. The primary analysis was conducted among 100 women (mean age 40±8 years), who has been using biomass fuel in traditional stoves for 20±9 years. They were all non-smoker with low (<5 µg/L) exposure to water arsenic and not known to have any CVD. Average 48 hour exposure to PM2.5, BC and CO was 124µg/m<sup>3</sup> (SD 108), 4.8 µg/m<sup>3</sup> (SD 2.1) and 1.2 ppm (SD 0.9) respectively. Mean cIMT is 740.9µm (SD 78). We will construct a multiple linear regression model and strength of association adjusted for important co-variables will be reported. We plan to complete data analysis on 200 samples by June 2018 and expect to present the finding at the ISEE meeting. Findings will help establish effects of HAP on atherosclerosis providing insights into magnitude, underlying mechanism and prevention strategies of the problem.

### **P03.1040. The Association of Premature Ovarian Failure (POF) and Air Pollution in Korea Based on Health Insurance Cohort Data**

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Abstract: [Background] Recently prevalence of premature ovarian failure (POF) continues to increase in Korea and we found that Kwanwon province showed the highest POF prevalence among sixteen provinces. The purpose of this study is to find the hot spot areas among 234 administrative districts with significant variables associated with POF prevalence. [Methods] We used the customized cohort DB from 2004 to 2013 provided by National Health Insurance Corporation. The total number of women in DB was 556,467 and the number of POF patients was 4,870. We estimated the POF prevalence in each districts and hot spot analysis was done to find the POF clusters. And we also evaluated the association between POF prevalence and environmental factors including air pollution data from air monitoring data with drinking, smoking, obesity, stress, education, income, number of visits to clinics and hospitals from National Health Examination Survey data. [Results] Hot spot analysis showed highest areas including five districts in Kangwon and Gyeongsangbukdo provinces. And there were lowest areas, cold spot, including nine districts in Chungchung provinces. And only air pollution data including NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub> showed significantly associated with POF prevalence. We did the same analysis after excluding Kangwon province for reducing possibility of genetic effects of regional residents. OLS regression showed that NO<sub>2</sub> and O<sub>3</sub> were significantly associated with POF prevalence and there was no hot spot area after excluding Kangwon province. [Conclusion] The further study is needed to evaluate the association between POF prevalence and air pollution with distribution of POF related genes among residents in hot spot areas. [Acknowledgment] This work was supported by the Korea Ministry of Environment (MOE) as The Environmental Health Action Program (2016001360007).

### **P03.1060. Impact of Air Pollution on the Newborn Genome**

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**Abstract:** Background. The Northern Moravia Region is the most polluted region in the Czech Republic by particulate matter (PM<sub>2.5</sub>) and carcinogenic polycyclic aromatic hydrocarbons (c-PAHs) as benzo[a]pyrene (B[a]P) by heavy industry, traffic and local heating. This specific situation was used to study the impact of air pollution to newborns in the exposed district Karvina (K) and control district Ceske Budejovice (CB). Methods. Milk, blood and urine from 100 mothers and cord blood and urine from 100 newborns were collected in winter and summer in each district. Concentrations of c-PAHs were determined from HiVol samples of PM<sub>2.5</sub>. As biomarkers were determined DNA adducts by 32P-postlabeling, oxidative damage by 8-oxodG adducts and 15-2Ft-isoprostane, ETS by cotinine, gene expression profiles. PAHs were determined in breast milk and diet, monohydroxylated PAHs (OH-PAHs) in urine. Results. During the sampling, concentrations of PM<sub>2.5</sub> in summer were 21.54±11.78 mg/m<sup>3</sup> in K, 12.14±7.23 mg/m<sup>3</sup> in CB, in winter 55.35±38.74 mg/m<sup>3</sup> and 26.39±16.85 mg/m<sup>3</sup>, respectively. Concentrations of B[a]P in summer were 1.31±1.26 ng/m<sup>3</sup> in K, 0.44±0.63 ng/m<sup>3</sup> in CB, in winter 5.15±5.47 ng/m<sup>3</sup> and 1.43±1.37 ng/m<sup>3</sup>, respectively. Total DNA adducts in the cord blood in winter were 2.76±1.11 in K vs. 2.32±0.90 adducts/108 in CB (p<0.001), B[a]P-like DNA adducts were 0.72±0.28 in K vs. 0.62±0.28 adducts/108 in CB (p<0.001). 8-oxodG adducts (nmol/mmol creat.) in the urine of newborns in winter were 5.66±12.90 in K vs. 4.23±1.51 in CB (p<0.001). Very low concentrations of PAHs were measured in diet and breast milk samples. The amount of OH-PAHs in newborns urine from K in the winter season was 3.3 times higher when compared with less polluted locality of CB. Conclusions. Exposure to B[a]P represents the most significant risk of air pollution in the Czech Republic as more than 55% of population is exposed to > 1 ng/m<sup>3</sup>/year. Acknowledgement: Supported by the Grant Agency of the Czech Republic 301/13/458S.

**P03.1070. Preliminary Study to Determine the Association between Maternal Exposure to Fine Particulate Matter (PM2.5) and Adverse Pregnancy Outcomes in Lima, Peru**

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**Abstract:** Environmental exposure to fine particulate matter (PM) is associated with increased risks for respiratory and cardiovascular diseases as well as some kinds of cancer and pregnancy adverse outcomes. Among others, Lima, a mega city located in Peru, has been considered one of the most contaminated cities in Latin America with mean annual concentrations of PM<sub>2.5</sub> ranging from 35 to 16 µg/m<sup>3</sup> (mean value: 26 µg/m<sup>3</sup>). Besides that, there are no studies related to the effect of outdoor PM air pollution on pregnancy outcomes in Lima, Peru. The aim of this preliminary study is to determine the association between maternal exposure to PM<sub>2.5</sub> on pregnancy outcomes in a hospital-based linkage study in the metropolitan area of Lima. This study analyzes the data corresponding to the period between January 2007 and December 2009. Newborn data were obtained through the Perinatal Information System (SIP 2000 in Spanish) from two public hospitals in Lima, Peru. Preterm birth (PTB), small for gestational age (SGA) and birth weight (BW) were considered as pregnancy outcomes. Also, records of PM<sub>2.5</sub> during this same period were recorded. Linear and logistic regression analyses were used to predict adverse pregnancy outcomes associated with PM<sub>2.5</sub> exposure. Data included 4,173 births. Of the three pregnancy outcomes, the exposure to higher concentrations of PM<sub>2.5</sub> (3rd quartile) were associated with an elevated risk of preterm birth in the 1st trimester (OR 1.62, CI95% 1.06 - 2.49), 2nd trimester (OR 1.71, CI95% 1.13 - 2.58), and 3rd trimester (OR=1.87, CI95% 1.27 - 2.76). To sum up, maternal exposure to PM<sub>2.5</sub> during pregnancy increase risks for preterm births. Future studies are being carried out to expand the years of exposure according to the use of time-series analysis and the collection of current newborn data.

### **P03.1080. Exposure to Air Pollution during Critical Gestational Windows and Childhood Obesity**

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**Abstract:** Introduction: There is a growing body of literature that supports an association between prenatal air pollution exposure and increased risk of childhood obesity. However, relationships between prenatal air pollution and growth among preschool age children, a developmental stage that predates most child obesity onset, have not been well studied. Methods: In a pre-birth cohort of 495 children in Mexico City we measured body fat percentage at 7 years of age by bioimpedance. Our cohort was 53% male with mean body fat percentage of 23.3% (SD = 7.6); among females the mean body fat percentage was 26% (SD = 8.4). Average ambient fine particulate matter (PM2.5) exposure was estimated at the home address during pregnancy using a 1km resolution hybrid satellite land use regression model. Findings: We found that body fat percentage at 7 years of age was negatively associated with average PM2.5 exposure during pregnancy using a multivariable regression model ( $b = -0.074$ , 95% CI: -0.677, -0.048), when adjusted for child age, socioeconomic status, sex, and maternal pre-pregnancy weight (Adj R<sup>2</sup> = 0.095). Average first trimester PM2.5 exposure was similarly negatively associated with body fat percentage at 7 years, PM2.5 during the second or third trimesters, or during the first year postpartum, was not associated with body fat at either timepoint. Conclusion: Although the magnitude of this finding may be small to be clinically relevant; further work including distributed lag modeling and longitudinal models of phenotypic trajectories may reveal specific exposure windows that are important. Our finding may also suggest that lower body fat in the preschool age children who were exposed to higher prenatal PM2.5 reflects an altered growth trajectory with consequences for later obesity in puberty. We will follow the cohort into puberty and continue to examine these associations.

**P03.1090. Effect Modification of the Association between Ambient Air Pollution Exposure and Fecundity by Infertility Type among Women Undergoing In Vitro Fertilization**

Sabah Quraishi

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Abstract: Mounting evidence indicates air pollution (AP) is adversely associated with birth outcomes, but few studies characterize the association with fecundity. We evaluated the association between long-term ambient AP and outcomes in women undergoing in vitro fertilization (IVF). This study takes advantage the known date of pregnancy attempt in IVF and investigates if type of infertility acts as a modifier of the AP-live birth association. Clinical data on women initiating their 1st autologous IVF cycle in 2012-13 were obtained from four US clinics. Annual average exposure prior to IVF start were estimated at residential address using a national spatial model that used land use regression and universal kriging to estimate particulate matter  $\leq 2.5$  (PM<sub>2.5</sub>), PM<sub>10</sub>, and nitrogen dioxide (NO<sub>2</sub>). Modified Poisson regression was used to measure the association between AP and fertilization, pregnancy, pregnancy loss, and live birth. Additive effect modification (EM) of AP and live birth by type of infertility (diminished ovarian reserve (DOR), male, ovulation, tubal) was evaluated using relative excess risk due to interaction (RERI). Higher exposure to PM<sub>2.5</sub>, by IQR-unit, was associated with a lower likelihood of live birth (RR:0.96, 95%CI:0.90-1.02) and higher likelihood of pregnancy loss (RR:1.09, 95%CI: 0.93-1.26). Results were similar for PM<sub>10</sub> and NO<sub>2</sub>. RERI analysis resulted in negative values, indicating lower likelihood of live birth with EM on an additive scale comparing high AP and DOR (PM<sub>2.5</sub>,PM<sub>10</sub>,NO<sub>2</sub>, all p<0.01) or high AP and male infertility (PM<sub>2.5</sub>,PM<sub>10</sub>,NO<sub>2</sub>, all p<0.001) with low AP and no DOR or male factor, respectively. Despite suggestive but uncertain findings for the association between AP and IVF outcomes, we found an indication of synergistic effects of AP and DOR or male infertility on the likelihood of live birth in women undergoing IVF. This suggests that DOR and male infertility should be further explored in future research evaluating effect of AP on fecundity.

### **P03.1100. Association between Ambient Air Pollutants and Preterm Birth in Ningbo, China: A Time-Series Study**

Zhe-Bin Yu

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**Abstract:** Background: Exposure to air pollutants has been related to preterm birth, yet evidence for PM<sub>2.5</sub>, O<sub>3</sub> and CO is relatively limited in China. This study aimed to investigate the short-term effect of exposure to air pollutants on preterm birth risk during 2014-2016 in Ningbo, China. Methods: We conducted a time-series study to evaluate associations between daily preterm birth and major air pollutants (PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub> and CO) in Ningbo during a three-year period (2014-2016). The relationship between preterm birth and air pollution was analyzed by General Additive Model extend Poisson regression to control for time-trends, meteorological factors and day of the week(DOW). We also conducted subgroup analysis by season and age. Results: In this study, a total of 37,389 birth occurred between 2014 and 2016 from the Electronic Medical Records System of Ningbo Women and Children's Hospital and among which 5428 were defined as preterm birth. The single pollutant model suggested that lag effect of PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub> reached a peak at day 3 before delivery, and no significant relationships were found for O<sub>3</sub>, CO and preterm birth. An increase of 10 µg/m<sup>3</sup> of air pollutants corresponded to excess risks (ERs) of 2.05(95%CI: 0.98~3.14) for PM<sub>2.5</sub>, 1.30(95%CI: 0.46~2.15) for PM<sub>10</sub>, 9.2(95%CI: 5.76~12.74) for SO<sub>2</sub>, 4.19(95%CI: 2.19~6.24) for NO<sub>2</sub>, -0.23(95%CI: -1.21~0.77) for O<sub>3</sub>, and 0.08(95%CI: 0.00~0.16) for CO. The effect of air pollutant remained significant when we restricted our analyses in pregnant women aged between 18 and 35 years . Conclusions: This study indicates that short-term exposure to air pollutants such as PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub> are positively associated with risk of preterm births in Ningbo, China.

### **P03.1110. Critical Windows of Ambient NO<sub>2</sub> Exposure on Fetal Growth at Late Pregnancy**

Carmen Iñiguez

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**Abstract:** Objective Our aim was to assess critical windows of weekly exposure to ambient NO<sub>2</sub> on ultrasound-measured fetal growth in a cohort of pregnant women from Valencia, Spain, (INMA project). Methods Ultrasounds were performed around 12, 20 and 34 weeks of pregnancy for all women (n=787) and measurements of biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL) were used to estimate fetal weight (EFW). A longitudinal growth curve for each parameter was fit with linear mixed models, adjusted for maternal height, weight, age, parity, and ethnicity. Growth curves were used to calculate SD-scores at week 34, which served as outcomes in this analysis. Weekly residential NO<sub>2</sub> exposure was estimated by temporally adjusted Land-Use Regression based on ambient NO<sub>2</sub> concentrations for 93 sampling points covering the study area and the existing ambient monitoring network of the city. Distributed lag non linear models, adjusted for socioeconomic and lifestyle variables, were used to explore critical weeks of exposure. Effect estimates were summarized as percent change (%CH) per 10 µg/m<sup>3</sup> increase in NO<sub>2</sub>. Results NO<sub>2</sub> exposure in gestational weeks 4-8 was inversely associated with BPD, with peak magnitude at week 5 (%CH=-0.87, 95%CI=-1.49, -0.25). NO<sub>2</sub> exposure was inversely associated with AC in weeks 16-21 and with EFW in weeks 18-21. In both cases the association peaked at week 19 [AC %CH=-0.87 (-1.37, -0.25) and EFW %CH=-0.65 (-1.20, -0.09)]. NO<sub>2</sub> exposure was not associated with FL. Discussion This study indicates that early pregnancy may be a critical window of exposure to outdoor NO<sub>2</sub> for head size and mid pregnancy may be for weight. Results were in line with a previous study using the same data, but the present method allowed for an agnostic and refined assessment of potential windows of susceptibility without using a priori definitions (e.g. trimesters). Funding: ISCIII-FEDER ( PI13/1944, MS11/0178, MSII16/00051, MS16/00128) and Alicia Koplowitz Foundation 2017.

### **P03.1120. Air Pollution Fluctuations and Adverse Pregnancy Outcomes in a Community of Southwest Bogota during 2016**

Rodrigo Sarmiento

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**Abstract:** Background: Air pollution and pregnancy outcomes have been widely described, however less is known about the temporal fluctuations and their health impact. Southwest communities in Bogota are the most vulnerable population to air pollution having a PM10 annual average of nearly 80 mcg/m<sup>3</sup>. Aim of the study was to identify potential adverse effects during advanced pregnancy according to the temporal patterns of air pollution in a deprived community in Bogota. Methods: A cross sectional study of women from 28 to 42 weeks of pregnancy that assisted at a second level hospital in Bogota's Southwest during 2016 was carried out. The sample included 126 women that were divided in two groups: A group of high levels of exposure that had their pregnancy during the dry season and the other one that had their pregnancy during the rainy season. PM10 was used as exposure variable and the outcomes were birth weight, systolic and diastolic blood pressure. PM10 level was adjusted by rainfall and temperature. Statistical analysis included t-test for independent samples and linear regression. Results: There were differences between mean PM10 during dry season (89 mcg/m<sup>3</sup>) and mean PM10 during the rainy season (66 mcg/m<sup>3</sup>) (p<0,05). Birth weight was significantly less (Mean difference=-388,1 gr, UI 95%: -507 a -268) in the group of high levels of exposure (2903kg ± 358,4) compared to the other group (3291kg±288,1). Such difference persisted during lineal regression after adjusting for temperature and cumulative rainfall (Beta=0.59 p<0.05). Other outcomes that were assessed did not show significant differences according to the levels of exposure. Conclusions: A temporal pattern of air pollution exposure and birth weight was observed in a polluted area of Bogota. Such findings have implications in maternal and child health and outline the importance of including these temporal variations on air pollution surveillance and control initiatives.

### **P03.1130. Associations of Industrial Air Pollutant Mixtures with Preterm Birth and Small for Gestational Age in Alberta, Canada**

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**Abstract:** Introduction: Effects of mixtures of chemicals released to the air by industrial facilities on pregnancy outcomes have been scarcely studied. We conducted a retrospective population-based cohort study to estimate associations of spontaneous preterm birth (sPTB), induced preterm birth (IPTB) and small for gestational age (SGA) with industrial air pollutant mixtures in Alberta, Canada (2006-2012). Methods: We used data from all singletons live births (n=330,957) including maternal data on 21 related risk factors. From the Canadian National Pollutant Released Inventory, we extracted 130 chemicals released into the air by 6,279 industrial facilities. We grouped all chemicals into ten broad classes including gases (e.g., CO), particulate matter (PM), Volatile Organic Compounds (VOCs), Metals, Other-inorganics, and Other-organics. We profiled the mixtures using a novel approach based on the proportional content of the ten chemical classes in the total amounts released by each facility using cluster analysis. Proximity to the facilities emitting mixtures (10-km) from the maternal postal codes at delivery was used as a proxy of exposure. Associations of the mixtures with sPTB, IPTB and SGA were assessed by logistic regression adjusting for relevant maternal risk factors and an area-level socioeconomic status. Results: We profiled eight broad groups of mixtures. Heterogeneous mixtures (including gases, PM and different proportional participation of the other chemical classes) were common (47% of the total emissions) and increased the odds of sPTB by 36% (OR=1.36; CI:1.30-1.63). Scarce mixtures with a high content (>60%) of VOCs increased the odds of SGA by 37% (OR=1.37; CI:1.11-1.69). Mixtures with a high proportion of Metals-, Other-organics- and Other-inorganics increased the odds of IPTB by 17% (OR=1.17; CI:1.05-1.30), 17% (OR=1.17; CI:1.06-1.28) and 24% (OR=1.24; CI:1.09-1.41) respectively. Conclusion: Mixtures showed differential associations with sPTB, IPTB, and SGA.

**P03.1140. Prenatal, Early-Life and Lifetime Exposure to Air Pollution and Childhood Lung Function and Asthma: The Avon Longitudinal Study of Parents and Children (ALSPAC) Cohort Study**

Yutong Cai

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**Abstract:** Background: Only a few studies have investigated early-life air pollution exposures on childhood lung function and asthma, with inconsistent results. We examined associations of exposure to air pollution during pregnancy, infancy and lifetime periods with lung function and current asthma in the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort. Methods: Forced expiratory volume in 1 second (FEV1) and Forced vital capacity (FVC) were measured at age 8 years and converted into age-height-gender adjusted z-scores. Current asthma was derived from answers to relevant questionnaire items. Exposures to source-specific particulate matter with a diameter  $\leq 10\mu\text{m}$  (PM10) during each trimester, 0-6 months, 7-12 months (1990-1993) through childhood up to age 8 years (1991-2001) were estimated using a dispersion model, accounting for residential mobility. Linear and logistic regression models were fitted to explore the associations, adjusting for gestational age, damp and mould at home, passive smoking exposure, home ownership, maternal education and smoking during pregnancy. Results: 13,963 study children were included in this analysis. At age 8 years, exposure to interquartile (IQR) higher PM10 ( $0.72\mu\text{g}/\text{m}^3$ ) from road traffic during the first trimester was associated with lower FEV1 ( $-0.05$ , 95%CI:  $-0.08$  to  $-0.02$ ) and FVC ( $-0.05$ , 95%CI:  $-0.08$  to  $-0.02$ ) z-scores. Similar significant associations were also seen with PM10 in the second and third trimester, 0-6 months, 7-12 months and 0-7 years. Associations were stronger among children whose mother had a lower education level or smoked during pregnancy. PM10 from all sources during the third trimester was significantly associated with lower FVC z-scores. Current asthma was not associated with PM10 at any time periods. Conclusion: Preliminary results suggested that exposure to road-traffic PM10 from as early as in the first trimester may result in small but significant reductions in lung function at age 8 years.

### **P03.1150. Assessing the Effects of Residential Mobility on Air Pollution Exposure Misclassification in Longitudinal Birth Cohort Studies**

Andy Boyd

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**Abstract:** To accurately assess environmental exposures in longitudinal cohort studies, a better understanding is needed about the effects of incomplete or inaccurate records of residential mobility on exposure misclassification. We developed an ALgorithm for Generating Address Exposures (ALGAE) that assigns air pollution exposure using residential address histories. We applied ALGAE to address records and historic daily air pollution estimates (particulate matter  $\leq 10 \mu\text{m}$  [PM<sub>10</sub>]) for the Avon Longitudinal Study of Parents and Children (ALSPAC). ALSPAC recruited 14,541 pregnant women between 1990 and 1992 in the South West of England. For each pregnancy, we modelled pregnancy trimester- and first year of life-specific exposure estimates based on PM<sub>10</sub> concentrations at residential address at birth and using reconstructed address histories to account for mobility during pregnancy and first year of life. We were able to assign trimester-specific PM<sub>10</sub> exposures for 12,752 pregnancies and first year of life exposures for 12,252 pregnancies. Average PM<sub>10</sub> exposures were 32.6  $\mu\text{g}/\text{m}^3$  (StDev 3.0  $\mu\text{g}/\text{m}^3$ ) during pregnancy and 31.4  $\mu\text{g}/\text{m}^3$  (StDev 2.6  $\mu\text{g}/\text{m}^3$ ) during first year of life. 6% of women moved address during pregnancy, and 13% moved during first year of life. Exposure differences ranged from -5.3  $\mu\text{g}/\text{m}^3$  to 12.4  $\mu\text{g}/\text{m}^3$  (up to 26%) during pregnancy and -7.22  $\mu\text{g}/\text{m}^3$  to 7.64  $\mu\text{g}/\text{m}^3$  (up to 27%) in first year of life between the exposure assessed using the address at birth compared to the exposure assessed using the complete cleaned address history. Accounting for residential mobility in the exposure assessment of birth cohort studies has the potential to substantially reduce exposure misclassification for some individuals. ALGAE provides an open-source solution to clean addresses stored in the cohort contact database and assigns life-stage specific exposures. Its generic code base means that it is adaptable for other cohort studies.

**P03.1160. Associations between Infant Birth Weight and Seasonal Variations in PM2.5 Exposure during Pregnancy: A Prospective Cohort Study in a Rural Community in China**

Yan Li

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**Abstract:** Background: Exposure to PM2.5 (fine particulate matter) pollutants in pregnancy has generally been found to be associated with infant low birthweight. In rural China, exposure of pregnant women to PM2.5 from indoor coal or wood-burning heaters, stoves and second-hand smoke is expected to have seasonal variations that may have implications on the birth weight of the offspring. Methods: In a prospective pregnant woman cohort study, 380 pregnant women carried a Portable Particle Monitor to measure 24-hour individual exposure to PM2.5 over a period of 5-7 days at first (T1), second (T2) and third trimester (T3) time points. The questionnaires to women were conducted simultaneously. Newborn were weighted by standard scale at birth. Latent Variable Growth Curve Modeling was used to elucidate the effects of seasonal variation to PM2.5 exposure in the course of pregnancy on the birth weight. Four groups were compared based on the season when the mother was in first trimester. Results: The average PM2.5 exposure throughout pregnancy were 27.2, 26.3, 28.3, and 30.9  $\mu\text{g}/\text{m}^3$  in four groups (their first trimester in Spring, Summer, Autumn and Winter), respectively. Different groups revealed special associational patterns. Intercept factors were -25.8, -51.3, -27.0, and -43.1 for mothers in first semester in Spring, Summer, Autumn and Winter respectively and slope factors were 0.8, -3.7, 8.4, and 8.2, respectively. Mothers in first trimester in Summer had newborns with the lowest birth weight with an increase of one unit of PM2.5 exposure being associated with a decrease in 51.3g in birth weight. Conclusions: PM2.5 exposure was associated with low birth weight across all 4 groups. Mothers who were not exposed to winter had newborns with the highest birth weights. Increased exposure to PM2.5 in the cold seasons may cause the decrease of birth weight and was associated with low birth weight.

### **P03.1170. A Stratified Repeated Measures Design to Examine Acute Effects of Air Pollution on Preterm Birth**

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**Abstract:** Background: Epidemiological study of preterm birth typically relies on birth certificate data for which records of gestational age are imprecise, leading to outcome misclassification biases that confound short-term temporal patterns for this outcome. We hypothesize that these biases hinder analysis of acute effects of pollutants using standard time-series approaches and propose an alternative study design as a solution. Methods: We group subjects into strata based on recorded date of last menstrual period and formulate each stratum as a cohort undergoing a repeated measures experiment. To render this design computationally tractable, we make use of t-distributed auxiliary variables and specify a model having two sets of non-nested random intercepts. We demonstrate the approach by estimating a multi-pollutant distributed lag model for births among women living within a 5-km radius of a criteria air pollutant monitor located in downtown Los Angeles during 1998-2012. Results: Compared to those of standard models, our coefficients have larger magnitudes and tend to be monotonically consistent across sequential quartiles of exposure. Both harmful and protective effects are observed, the latter potentially reflecting beneficial delays in delivery arising from clinical interventions directed at women hospitalized for potential preterm delivery. Conclusions: Distributed lag coefficients generated by this method suggest complex, non-random temporal relationships between criteria pollutants and preterm birth risk. While these results fail to demonstrate a simple cause-effect relationship, the method holds promise for advancing our understanding of short-term pollutant effects on this outcome.

### **P03.1180. Benzene Low-Level Personal Exposure Assessed Repeatedly and Fetal Growth: Are Effects Observed in the General Population?**

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**Abstract:** Context: Benzene is a recognized reprotoxicant but its effects on fetal growth in humans at levels encountered in the general population are poorly known. A study reported decreases in head circumference and possibly birth weight in association with maternal benzene exposure. Aim: To study the possible effect of airborne benzene pregnancy exposure on fetal growth using personal monitoring. Methods: We relied on SEPAGES, a cohort of pregnant women recruited before gestational week 20, who carried personal benzene monitors for two to three 8-day periods. Offspring weight and head circumference were related with benzene levels at each measurement week and averaged over all weeks through adjusted linear regression models. Results: Median (25-75th centiles) benzene 8-day exposure at the first measurement was 1.4 (0.8; 2.2)  $\mu\text{g}/\text{m}^3$ . The correlation of benzene 8-day levels between the first and last measurement periods was 0.25 ( $p < 5.10^{-4}$ ), while for exposure averaged over all measurement periods, benzene levels had a correlation of 0.05 ( $p = 0.4$ ) with nitrogen dioxide and of 0.23 ( $p = 0.001$ ) with PM<sub>2.5</sub> personal exposures. Each unit increase in benzene mean exposure was associated with a mean birth weight change by -18 g (95% confidence interval, CI, -43; 7 g,  $n = 402$ ), while mean head circumference changed by -1.0 mm (95% CI, -1.9; -0.2). Across measurement periods, the strongest association was observed with the first benzene measurement, both for birth weight (change, -30 g; 95% CI, -56; -3) and head circumference (-1.7 mm, 95% CI -2.6; -0.8,  $p < 5.10^{-4}$ ). There was no strong attenuation after adjustment for personal NO<sub>2</sub> or PM<sub>2.5</sub> exposure. Conclusion: This study is the first to characterize possible effects of benzene on birth weight using personal repeated measurements. It provides a confirmation of an association of benzene exposure with head circumference, and suggests that the association is stronger for exposures in the 1st (as opposed to 2nd) half of pregnancy.

**P03.1190. Study on the Relationship between Air Pollution and Insulin Resistance Based on Branched-Chain Amino Acids Analysis**

Jicheng Gong

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**Abstract:** Background: Studies showed associations between air pollution exposure and the incidence of diabetes; however, the evidence on the underlying mechanism is limited. Insulin resistance (IR) has been recognized as an important pathogenesis of the metabolic syndrome and type II diabetes. There were studies found that the branched-chain amino acids (BCAAs), including leucine, isoleucine, and valine, could affect the sensitivity of insulin. And it also shown that exposure to air pollution, e.g. ozone, could increase BCAAs' levels in blood. Therefore, we may assume exposure to air pollution has effects on the insulin resistance through the mediation of BCAAs. Method: To examine this hypothesis, we measured BCAAs in serum samples of 120 subjects from an existing panel study (SCOPE). 130 observations from 83 subjects (37 with pre-diabetes, 46 with normal fast glucose level) were included in this preliminary analysis. Serum BCAAs were analyzed by using a UPLC-QQQ-MS. The associations among BCAAs, IR and air pollution exposure were analyzed using Mixed-effects models. Results: The average ( $\pm$  SD) concentrations of leucine, isoleucine and valine in serum were  $148.6 \pm 33.0$   $\mu$ M,  $70.7 \pm 19.1$   $\mu$ M, and  $247.0 \pm 54.9$   $\mu$ M, respectively. We found a significantly higher level of the total BCAAs (combined three BCAAs together) in subjects with pre-diabetes than healthy ones with  $p = 0.004$ . Three individual and the total BCAAs were statistically significantly associated with HOMA-IR which is an indicator of insulin resistance with  $p < 0.042$ . We did not observe statistically significant associations between BCAAs and PM<sub>2.5</sub> or ozone in this preliminary analysis, but valine showed a marginally significant association with ozone ( $p = 0.052$ ). Tentative conclusion: The significant associations observed between BCAAs and insulin resistance from the preliminary analysis suggest BCAAs a potential mediator of insulin resistance. More data are needed to examine the associations between BCAAs and air pollutants.

### **P03.1200. Short-Term Exposure to Ambient Particulate Elements and Epigenome-Wide DNA Methylation in Older Men: The Normative Aging Study**

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**Abstract:** Background: Current research suggests that short-term exposure to ambient particulate matter is associated with global and gene-specific DNA methylation (DNAm), but little is known regarding the changes in epigenome-wide caused by particulate elements (PEs). Additionally, the potential pathways remain unknown. Objective: We evaluated whether short-term exposure to ambient PEs affects DNAm in epigenome-wide and identified potential biological pathways. Method: We collected whole blood samples from the Normative Aging Study (1999-2013) and measured epigenome-wide DNAm with the Illumina Infinium HumanMethylation450 BeadChip. Ambient PEs were measured daily at a fixed monitoring station and 7 different moving averages (from 1-day to 7-day) were considered. Linear models were used to estimate the associations between 14 elements and DNAm measured in baseline (N=774), adjusting for fine particle mass, cell type, batch effects, age, body mass index, smoking, etc. Pathway analysis was also performed to explore the potential biologic mechanisms. Results: Short-term exposure to PEs was significantly associated with epigenome-wide DNAm, especially for 2-d moving average. We observed 393 Bonferroni significant CpGs, most of them related with Aluminum, Silicon, Sulfur, and Potassium. The pathway analyses suggest that the detrimental effects might be relevant to immune response and signal transduction. We also found that there were several common genes significantly associated with Aluminum, Silicon and Sulfur, such as, Alzheimer's disease related gene Low density lipoprotein Receptor Related Protein 1; obesity-related gene Protein Tyrosine Phosphatase, Receptor Type F; and cancer related gene Lysophosphatidylcholine Acyltransferase 1. Conclusions: Ours is the first study that find short-term effects on DNAm in epigenome-wide by ambient PEs, especially elements associated with road dust, sulfate and wood burning. Our findings provide insight into potential mechanistic pathways.

### **P03.1210. Fe Concentration in Tree Barks: A Proxy for the Concentration of PM10**

Carmen Diva De André

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**Abstract:** Chemical element analysis in tree barks is being used to access the variability of urban air pollutant concentrations with high spatial resolution. We conducted an observational study in São Paulo, Brazil, where vehicle emissions are the main source of air pollution. **Aim:** Verify which trace elements in tree barks may be used as proxies for PM10 concentration in this urban scenario. **Methods:** Samples of barks from 498 trees (193 *Tipuana tipu*, 228 *Poincianella pluviosa* and 77 *Ligustrum* sp.) were collected near streets with different traffic intensities. Al, Ba, Ca, Cl, Cu, Fe, K, Mg, Mn, P, S, Sr and Zn concentrations were evaluated by energy dispersive X-ray fluorescence (EDXRF) spectrometry. Principal component analyses, considering robust correlation coefficients, were performed with the objective of identifying the sources of the chemical elements, with and without separation by species. Considering 14 trees located around air quality monitoring stations, the association between element concentrations in the tree barks and the annual PM10 (evaluated by Beta Attenuation method) mean concentration in the year preceding the bark sampling was evaluated via regression models. A forward stepwise procedure was adopted in the process of model fitting. **Results:** Regardless of species, the first principal component was related to vehicular emissions and explained 45% of the total variance. Fe was the element with the largest correlation with this component, both when a correlation matrix containing robust correlation coefficients was considered or not. In the fitting of the regression model, no other element related with vehicular sources had additional contribution to explain the PM10 variability ( $R^2=80\%$ ). **Conclusion:** Fe in tree barks may be used to access the spatial variability of long term PM10 concentrations. The results of this preliminary study are in line with recent research that proposes magnetic analysis of tree barks for air pollution biomonitoring purposes.

### **P03.1220. Susceptibility of Individuals with COPD to Air Pollution Exposure: A Case-Control Panel Study in Beijing, China**

Tong Zhu

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**Abstract:** Introduction Chronic obstructive pulmonary disease (COPD) is one of the leading causes of death worldwide, characterized by chronic inflammation, and is one of the main diseases contribute to mortality attributable to PM<sub>2.5</sub>. Exposure to air pollution is one of the high-risk factors contributing to occurrence and development of COPD, it is important to reveal the biological mechanism of inflammation associated with exposure to air pollution in COPD patients and to know if subjects with COPD are more susceptible to air pollution than health one. Methodology With a case-control panel study (COPD), we recruited 44 stable COPD patients and 58 healthy control from Beijing Xicheng District Shichahai Community Health Center. Each subject has undergone 4 times repeated clinical visits from 2016 to 2017. Biomarkers, including breath volatile organic carbons, lung function, fractional exhaled nitric oxide (FeNO), fasting blood and cholesterol, inflammatory cytokines and cells, heart rate and blood oxygen were repeatedly collected from each subject in four visits. Gaseous air pollutants along with detailed chemical components and size distribution of particulate matter were continuously measured before and during each visits, 24 hours personal exposure to PM<sub>2.5</sub> of each subjects prior to clinical visit was measured with a personal PM<sub>2.5</sub> sampler. Linear mixed-effect model was fitted to estimate the association. Results Preliminary results shows increases in the levels of FeNO and heart rate, and decreases in the capabilities of pulmonary ventilation following air pollution exposure were more serious in the COPD patients, and adjusted by the forced expiratory volume. The association these effects with the exposure to CO, SO<sub>2</sub>, black carbon, organic carbon, and ultrafine particles were most robust. Conclusions After exposure to air pollution, the COPD patients had higher acute responses and worse capability of inflammatory regulation.

### **P03.1230. Airplane Pilot Performance in a Flight Simulator Under Varying Carbon Dioxide Concentrations**

Xiaodong Cao

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**Abstract:** Recent studies suggest that carbon dioxide has an impact on cognitive functions of office workers at concentrations in the range of 1000-2500 ppm. Reports of CO<sub>2</sub> concentrations on airplanes are in the same range, so we were motivated to test the impact of CO<sub>2</sub> on airplane pilot performance. In this study, we recruited 30 active commercial airline pilots to fly three 3-hour flight segments in an FAA-approved flight simulator under three different CO<sub>2</sub> concentrations (700, 1500, 2500 ppm), each time blinded to test conditions and with the order of exposures randomized. CO<sub>2</sub> concentrations were directly modified by introducing ultra-pure CO<sub>2</sub> into the simulator with the ventilation rate unchanged. The pilots performed a series of pre-defined maneuvers of varying difficulty without the aid of autopilot and were assessed by an FAA Designated Pilot Examiner according to FAA Practical Test Standards. The results showed that airplane pilots performed better at lower CO<sub>2</sub> concentrations on the flight deck. Compared to segments at a CO<sub>2</sub> concentration of 2500 ppm, the odds of passing a maneuver as rated by the Examiner in the simulator were 1.52 (95% CI: 1.02 - 2.25) times higher when pilots were exposed to 1500 ppm and 1.69 (95% CI: 1.11 - 2.55) times higher when exposed to 700 ppm, controlling for maneuver difficulty, Examiner and order of maneuvers. The effect of CO<sub>2</sub> on passing rates became more pronounced the longer the pilots were in the simulator. These findings suggest that there is a direct effect of carbon dioxide on cognitive performance, independent of ventilation, with implications for many other indoor environments that routinely experience CO<sub>2</sub> concentrations above 1000 ppm.

### **P03.1240. The Effect of Seasonal Fine Dust Concentrations on the Well-Being of Citizens in Seoul**

KilYong Choi

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**Abstract:** Numerous research studies have been conducted on the effects, risks, and prevention of the exposure to aerial pollutants. Particulate matter and urban air pollution affect the human body and can lead to death. Epidemiological studies should consider the exposure to pollutants and the diverse responses of individuals depending on their sensitivity to the pollutants. In this study, air pollution measurements were obtained hourly at measuring stations operated by the national and local governments to increase the reliability of the measured values. A  $\beta$ -ray absorption method was used to analyze the measurements of fine dust and determine the particulate matter content. The air pollution data were log-converted to enable the comparison of data from different time periods. A seasonal analysis of the data indicated that the concentration of fine dust in Seoul was higher in the autumn, winter, and spring than in the summer. The data on individual characteristics were obtained from a survey of Seoul citizens conducted from 2014 to 2016 and using indicators such as the quality of life and social trust of Seoul citizens. The survey on the living environment and residence indicated that 80% of the heads of households were men. Women had a greater dissatisfaction than men with the residential, economic, and social environments. The survey questions on well-being were related to the internal and external environment such as air pollution, noise, and fine dust.

**P03.1250. Exposure to Air Pollutants and Variation of Blood Glucose Level among Gestational Diabetes Mellitus in China: A Retrospective Cohort Study**

Die Li

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**Abstract:** Background: Air pollution has been reported to be associated with risk of type 2 diabetes, but few studies were available for the associations with blood glucose level in pregnant women. Objectives: We aimed to examine the effects of exposure to air pollution on blood glucose in GDM patients in a retrospective cohort study. Methods: We identified GDM cases from hospital records among 35,722 women who were pregnant from January 2013 to May 2017. We used generalized additional models to estimate adverse effects of air pollution on fasting blood glucose and OGTT among GDM patients. Results: We identified a total of 1,347 women with GDM. An IQR increase in NO<sub>2</sub> exposure during the second trimester was associated with an increment of fasting blood glucose (FBG) level by 0.42mmol/L. Significant associations were observed among women with younger age ( $\beta=0.55$ ,  $p<0.05$  for CO), overweight/obesity ( $\beta=0.52$ ,  $p<0.05$  for NO<sub>2</sub>,  $\beta=0.70$ ,  $p<0.05$  for CO), lower education ( $\beta=1.08$ ,  $p<0.05$  for NO<sub>2</sub>,  $\beta=0.83$  for CO), and among manual labor ( $\beta=1.12$ ,  $p<0.05$  for NO<sub>2</sub>) and housewife ( $\beta=1.46$ ,  $p<0.05$  for CO). Our estimates for air pollutants (NO<sub>2</sub> and CO) and OGTT were generally consistent with the corresponding  $\beta$  values for FBG. No evidence was observed for the association between particle matter, SO<sub>2</sub> and Particle Matter exposure and FBG/OGTT level in our study. Conclusions: In the present study, women were at increased risk for higher blood glucose level when exposure to higher residential NO<sub>2</sub> and CO during their pregnancy. Women with higher BMI, lower education level were more susceptible to the adverse effects of ambient air pollution.

### **P03.1260. Daily Time in Transportation and Traffic by Urban Canadians**

Carlyn Matz

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Abstract: Traffic is an ever-present issue in urban centers and exposure to traffic and traffic-related air pollution is associated with wide-ranging health effects. Results from the Canadian Human Activity Pattern Survey (CHAPS) 2 were used to evaluate daily time spent in transportation and traffic by urban Canadians. It was estimated that Canadians spend 4-7% of daily time in on- or near-road locations, mainly from time spent in a vehicle with smaller contributions from time spent in active transportation. Furthermore, when in a vehicle, 44-61% of the target population was in moderate to heavy traffic. In addition, 11-22% of the target population was in moderate to heavy traffic while engaged in active transportation. Over 60% of the target population reported living near a busy roadway, which varied with income level and city of residence. People living near major roadways also spent more daily time in the vicinity of moderate to heavy traffic. Over 55% of the target population  $\leq 18$  years reported attending a school or daycare in close proximity to a busy roadway, with little variation based on income level and city. Overall, these results indicate that urban Canadians spend a considerable amount of daily time in transportation and traffic-influenced microenvironments. Quantitative measures of time spent in these microenvironments provide support for initiatives or strategies designed to mitigate population exposure to traffic and traffic-related air pollution.

**P03.1270. Long-Term Exposure to Ambient Air Pollution and Cognitive Function in Older U.S. Adults: The Multi-Ethnic Study of Atherosclerosis and Air Pollution**

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Abstract: Background: Adverse effects of exposure to air pollution (AP) on cognitive function have been increasingly recognized. Little is known regarding whether specific sources of fine particulate (PM<sub>2.5</sub>) has more impact on cognitive function. Objectives: To evaluate the potential associations between long-term exposure to AP, including source-specific components in fine particles and cognition in older adults in the Multi-Ethnic Study of Atherosclerosis. Methods: Cognitive assessment, including the Cognitive Abilities Screening Instrument (CASI), Digit Symbol Coding (DSC), and Digit Span (DS), was completed in 4392 participants of mean age 70 in six areas of the United States during 2010-2012. Residence-specific AP exposures [i.e. oxides of nitrogen (NO<sub>2</sub>/NO<sub>x</sub>), PM<sub>2.5</sub> and its components: elemental carbon (EC), organic carbon (OC), sulfur (S) and silicon (Si)] were estimated by geo-statistical models. Linear regression models adjusted for individual-level characteristics were used to estimate the associations between each air pollutants and cognitive function. We also evaluated the effect of AP with race-specific low cognitive function (LCF) using a logistic regression model. Results: An interquartile (IQR) range increase in EC (0.8µg /m<sup>3</sup>) and Si (23.1ng /m<sup>3</sup>) was associated with -1.27 (95%CI: -0.09, -2.45) and -0.88 (95%CI: -0.21, -1.54) lower CASI score in global cognitive function. For each IQR increase in Si, the odds of LCF participants was 1.29 times higher (95%CI: 1.04-1.60) than the normal participants. For other tests, NO<sub>x</sub> was associated with slower processing speed (DSC: -2.01, 95%CI: -3.50, -0.52) and worse working memory (total DS: -0.4, 95%CI: -0.78, -0.01). No associations were found for PM<sub>2.5</sub> and its components (i.e. OC and S) with any cognitive function outcomes. Conclusion: Higher exposure to traffic-related air pollutants including both tailpipe (EC and NO<sub>x</sub>) and non-tailpipe (Si) species were associated with lower cognitive function in older adults.

### **P03.1280. High Environmental Ozone Levels and Extrinsic Skin Aging**

Tamara Schikowski

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**Abstract:** Introduction: We have recently reported a positive association of high levels of tropospheric ozone (O<sub>3</sub>) with extrinsic skin aging in the Berlin Aging Study II (BASE-II). In the current analysis, we combined two German cohorts and added a measure of an accumulated O<sub>3</sub> exposure. Material and Methods: We pooled two population-based cohorts: The older group of BASE-II participants (Berlin, 1,431 men and women aged 60-84) and the SALIA study (North Rhine-Westphalia, 806 women aged 67-80 years). We assessed facial coarse wrinkles and pigment spots as markers of extrinsic skin aging using the SCINEXATM tool. Five-year average residential exposure to O<sub>3</sub> at the postcode level was modelled with the Optimal Interpolation method by the Federal Environmental Office (Umweltbundesamt-FGII4.2) as (1) acute high exposure as count of days with maximal hourly concentration of O<sub>3</sub>  $\geq 120 \mu\text{g}/\text{m}^3$  ("exceedance") and (2) the accumulated daily exposure to O<sub>3</sub>  $\geq 40$  ppb from May to July ("AOT40"). We ran linear regression models, adjusting for age, sex, body mass index, education, smoking, alcohol consumption, and cohort. In a separate step, we adjusted for average residential ultraviolet (UV) erythemal dose in summer and co-pollutants coarse particulate matter (PM<sub>10</sub>) and nitrogen dioxide (NO<sub>2</sub>). Results: In the pooled analysis with two cohorts, O<sub>3</sub> was associated with more coarse wrinkles on the forehead: per 7 days of O<sub>3</sub> exceedance an increase by 7.6% (95%-CI: 1.1-14.1%), and per 2,000 ( $\mu\text{g}/\text{m}^3$ )\*h AOT40 by 4.1% (0.5-7.7%) in the wrinkles score. Both associations were robust to adjustment for UV and air pollutants PM<sub>10</sub> and NO<sub>2</sub>. We found no consistent associations between O<sub>3</sub> and pigment spots. Conclusion: Repeatedly high concentrations of ozone as well as accumulated O<sub>3</sub> exposure in summer were positively associated with coarse wrinkles, a marker of extrinsic skin aging. This association was independent from other air pollutants and UV exposure.

**P03.1300. Long-Term Exposure to Ambient Fine Particulate Matter and Liver Enzymes in 351,852 Adults: A Cross-Sectional Study**

Yacong Bo

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**Abstract:** Background: Animal experiments suggest that particulate matter can induce hepatotoxicity, but epidemiological evidence is scarce. We therefore investigated the associations between long-term exposure to fine particulate matter (PM<sub>2.5</sub>) and liver enzymes in a Taiwanese population. **Methods:** A cross-sectional analysis was carried out among 351,852 adults who participated in a standard medical screening program in Taiwan from 2001 to 2014. A venous blood sample was taken for the measurement of liver enzymes, including aspartate aminotransferase (AST), alanine aminotransferase (ALT) and  $\gamma$ -glutamyl transferase (GGT). A spatio-temporal model based on satellite-derived aerosol optical depth data was used to estimate ambient PM<sub>2.5</sub> concentrations at each participant's address. Linear regression models were used to investigate the associations between PM<sub>2.5</sub> exposure and liver enzymes. **Results:** Positive associations were found between PM<sub>2.5</sub> exposure and liver enzyme levels. After adjustment for a wide range of potential confounders, every 10  $\mu\text{g}/\text{m}^3$  increment in 2-year average PM<sub>2.5</sub> concentration was associated with 0.02% [95% confidence interval (CI): -0.04%, 0.08%], 0.61% (95% CI: 0.51%, 0.70%) and 1.60% (95% CI: 1.50%, 1.70%) increases in ALT and GGT levels, respectively. **Conclusions:** Long-term exposure to PM<sub>2.5</sub> is associated with increased liver enzyme levels, suggesting adverse effects of PM<sub>2.5</sub> exposure on liver function.

### **P03.1310. Development of Spatio-Temporal Land Use Regression Models for Gaseous Pollutants in London, UK, within the Steam Project**

Klea Katsouyanni

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**Abstract:** Background/Aim: Epidemiological studies either use fixed site monitor measurements or modeled estimates at subjects' residential addresses to estimate health effects of short or long-term exposures. Recent developments in exposure modeling provide spatially resolved daily estimates enabling an integrated assessment of health effects arising from both long-and-short-term exposures. Our aim was to develop a spatio-temporal land use regression (LUR) model that estimates daily concentrations of nitrogen oxides (NO<sub>x</sub>), nitrogen dioxide (NO<sub>2</sub>) and ozone (O<sub>3</sub>), in London, UK. Methods: Data from the extensive network of fixed monitoring sites in London were collected for the years 2009-2013, while LUR variables were derived from Land Cover Map 2007. We obtained road geography and information on road traffic flows from the Department of Transport. We applied a semiparametric approach using spatial covariates, meteorological data, time varying variables and a bivariate smooth thin plate function. The final set of explanatory variables was selected based on the adjusted-R<sup>2</sup>. Moreover, we developed hybrid models by incorporating chemical transport modeling (CTM) predictions, obtained within the STEAM project for the same area and time-period, into the developed spatio-temporal LUR models. Results: The adjusted-R<sup>2</sup> of the developed LUR models was 0.75 for NO<sub>x</sub>, 0.72 for NO<sub>2</sub> and 0.69 for O<sub>3</sub>. We performed a ten-fold cross-validation and the adjusted-R<sup>2</sup> were 0.74, 0.71 and 0.62 for NO<sub>x</sub>, NO<sub>2</sub> and O<sub>3</sub> respectively. Incorporation of the dispersion estimates in the LUR models as a predictor, improved the LUR model fit: CV-R<sup>2</sup> increased to 0.77 for NO<sub>x</sub>, to 0.76 NO<sub>2</sub> and to 0.75 for O<sub>3</sub>. Conclusions: Our study supports the combined use of LUR and CTM in a single spatio-temporal modeling framework to improve the accuracy of predictions for subsequent use in epidemiological studies.

### **P03.1330. Spatio-Temporal Land Use Regression Modelling of Ozone Levels in Athens, Greece**

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**Abstract:** Background and aims: Spatio-temporal methods have been developed for the estimation of concentrations of pollutants such as particulate matter (PM) and nitrogen dioxide (NO<sub>2</sub>) for application in epidemiological studies. A very limited number of city-specific spatio-temporal ozone (O<sub>3</sub>) models have been proposed recently. Our aim was to develop a spatio-temporal land use regression (LUR) model that estimates daily concentrations of O<sub>3</sub>, for the whole year, warm (April 1st to 30th September) and cold season (October 1st and 31st March), within the greater Athens area. Methods: We developed models using a semiparametric approach including linear and smooth functions of spatial and temporal covariates and a bivariate smooth thin plate function. The final set of explanatory variables was selected based on the adjusted-R<sup>2</sup>. We tested the final model in temporal and spatial terms following a leave-one out monitor approach. Results: The adjusted-R<sup>2</sup> of the developed annual model was 0.76, while for the warm and cold season it was 0.70 and 0.71, respectively. The spatial terms in our annual model explained 32.9% and the temporal 63.2% of the variability in O<sub>3</sub>. There was no remaining temporal or spatial autocorrelation in the residuals. The adjusted-R<sup>2</sup> in the leave-one-out cross validation was 0.73 for the annual model (warm: 0.65 and cold: 0.70). The developed models showed good validity when comparing predicted and observed measurements for the 2015 data. Conclusions: Spatio-temporal LUR modeling provides a useful tool for estimating O<sub>3</sub> spatio-temporal variability with adequate accuracy for subsequent use in epidemiological studies.

**P03.1340. Impacts of Air Pollution Wave on Years of Life Lost: A Crucial Way to Communicate the Health Risks of Air Pollution to the Public**

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Abstract: Limited studies have explored the impacts of exposure to sustained high levels of air pollution (air pollution wave) on mortality. Given that the frequency, intensity and duration of air pollution wave has been increasing in highly polluted regions recently, understanding the impacts of air pollution wave is crucial. In this study, air pollution wave was defined as 2 or more consecutive days with air pollution index (API)>100. The impacts of air pollution wave on years of life lost (YLL) due to non-accidental, cardiovascular and respiratory deaths were evaluated by considering both consecutive days with high levels of air pollution and daily air pollution levels in Tianjin, China, from 2006 to 2011. The results showed the durational effect of consecutive days with high levels of air pollution was substantial in addition to the effect of daily air pollution. For instance, the durational effect was related to an increase in YLL of 116.6 (95% CI: 4.8, 228.5) years from non-accidental deaths when the air pollution wave was sustained for 4 days, while the corresponding daily air pollution's effect was 121.2 (95% CI: 55.2, 187.1) years. A better interpretation of the health risks of air pollution wave is crucial for air pollution control policy making and public health interventions.

**P03.1370. Short-Term Effects of Ambient Air Pollution Exposure on Lung Function: A Longitudinal Study among Healthy Primary School Children in China**

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**Abstract:** Background: Short-term exposure to ambient air pollution has been associated with reduced lung function among asthmatic children. However, there is little information about the effects among healthy children, especially in areas with relatively high exposure background. Objective: To examine the association between short-term effects of ambient air pollutants and lung function among healthy primary school-aged children in China. Methods: A total of 334 healthy children (7-11 years) from four cities (Chengdu (Southwest China), Guangzhou (Southern China), Wuhan (Central China), and Xi'an (Northwest China)) in China with repeated lung function measurement in 2014-2016 were included. Daily ambient concentrations of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, mean temperature, and relative humidity data were obtained. Linear mixed model was used to estimate the percent change in lung function associated with per inter-quartile range (IQR) exposure (up to 3 days) increase after adjusting for confounders. Results: Ambient PM<sub>2.5</sub> and PM<sub>10</sub> exposure were significantly associated with decrements in FVC, FEV<sub>1</sub> and FEF<sub>25%</sub>. An IQR increase of two day average (lag01 day) PM<sub>10</sub> exposure (IQR, 144 $\mu$ g /m<sup>3</sup>) was significantly associated with 2.56% decrease in FVC, 5.46% in FEV<sub>1</sub>, and 7.35% in FEF<sub>25%</sub>. The effect estimates were stronger after adjusting for gaseous pollutants in particulate matter (PM) models. The strengths of these associations were stronger in girls than those in boys. Conclusion: Short-term exposure to PM<sub>2.5</sub> and PM<sub>10</sub> was associated with reduced FVC, FEV<sub>1</sub> and FEF<sub>25%</sub> in healthy children. The estimated adverse effects were greater in girls than in boys.

### **P03.1400. Impact of Air Pollution on Health in Abidjan Hospitals, Côte d'Ivoire**

Kouame Kouadio

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**Abstract:** Background/Aim Air quality is catching the attention of public opinion due to its impact on human health. In Côte d'Ivoire, there is no national air quality measurement system. However, data concerning cardiorespiratory and skin diseases in relation to poor air quality exist. In order to estimate the impact of air pollution on health in the city of Abidjan and determine pollutants' concentration, a pilot survey was carried out in two Health centres in the municipality of Cocody. **Methods** The survey was conducted in January 2015. Data of patients with cardiovascular, respiratory and skin diseases at two health centres of Palmeraie and Akouedo village in Cocody, which may be related to air pollution were recorded. Every day during 15 days, investigators filled the survey sheet. The informations were related to age, sex, reason for consultation, diagnosis and treatment received. All records were verified and analysed in Epi info software. **Results** 286 people were enrolled for 1,450 consultations at the two health centres. Palmeraie health centre received 1060 patients over the period of the survey for a total of 167 enrolled persons (30.5%). However, the Akouedo village received 390 patients for 119 enrolled (15.8%). Overall, women and children aged 1 to 15 were the most important patients represented 57% and 60% respectively. Bronchodilators (66), corticosteroids (37), cardiac therapy and skin medication for eczema (36) were mostly prescribed by practitioners. **Conclusions** The health centre of Akouedo appears to be a major centre of patients with diseases related to air pollution where the biggest dump is located. This work also showed that Women and children most vulnerable people may be exposed to air pollution. A survey with the concentration of pollutants and the impact will allow us to know the real link between pollutants concentration and diseases related to air pollution.

### **P03.1410. Effects of Air Pollution on Behavior Change in Healthy Rats**

Hsiao-Chi Chuang

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Abstract: Effect of air pollution on central nervous system (CNS) is poorly understood. The objective of this study is to investigate the roles of air pollution on CNS in rats. We established an experimental station nearby traffic emission sources in New Taipei City (Taiwan). The station equipped with ultrafine particle counter, DustTrakT II aerosol monitor, AEROTRAK nanoparticle aerosol monitor and MicroAeth black carbon monitor for particle monitoring as well as two exposure chambers for whole-body exposure of six-month-old SD rats (HEPA and PM2.5). After three months of exposure, rotarod performance test and novel object recognition (NOR) were performed. The daily average of particle number concentration (PNC) was 11599.2 cm<sup>-3</sup> with 53.1 nm in aerodynamic diameter. The PM2.5 mass concentration, black carbon (BC) and surface area concentration in alveolar region was 14.8 µg/m<sup>3</sup>, 1.8 µg/m<sup>3</sup> and 50.3 µm<sup>2</sup>/cm<sup>3</sup>, respectively. There was no significant difference in rotarod performance test between control group, HEPA group or PM2.5 group. Notably, we observed that the rats in PM2.5 group had the lowest NOR performance than the control and HEPA groups. In conclusion, sub-acute exposure to PM2.5 may have the effect on behavior changes in human.

### **P03.1420. Effect of Exposure to PM2.5 on the Fraction of Exhaled Nitric Oxide (FeNO): A Systematic Review and Meta-Analysis**

Liwen Zhang

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**Abstract:** Background: Many epidemiological studies showed that exposure to air pollutants has been linked with increased airway inflammation and respiratory morbidity and mortality. However, the effect of ambient fine particulate matter (diameter <2.5mm) (PM2.5) on FeNO remains controversial. The aim of this systematic review and meta-analysis was to investigate the association between exposure to PM2.5 and FeNO. Methods: Articles were searched in those seven databases (PubMed, Web of Science, Embase, China Biology Medicine disc, China National Knowledge Infrastructure, Wanfang Data and Wanfang Med Online) before October 15, 2017. A random-effects model was used to calculate FeNO change for each increment of 10µg/m<sup>3</sup> in PM2.5. Results: In the 840 articles identified articles, 28 studies met our eligibility criteria. Estimates are given as the absolute-value-change in 12 studies and as the percent-change in 16 studies. The overall combined estimates showed an increase of 10 µg/m<sup>3</sup> in PM2.5 levels was associated with a 0.61 ppb (95% confidence interval, 0.46-0.76 ppb) increase in FeNO in the absolute-value-change studies and a 1.07% increase (95% confidence interval, 0.42%-1.71%) in the percent-change studies. Subgroup analysis was conducted according to age and disease. In most of the sub-group analysis, the heterogeneity remained significant. By sensitivity analyses we found the pooled estimate was not significantly changed after excluding cross-sectional studies and trial studies [0.59 ppb (95% CI 0.44-0.75 ppb) in the absolute change studies; 1.48% (95% CI 0.90%-2.06%) in the percent change studies]. For assessment of the publication bias by funnel plots and Egger's tests, no significant publication bias was found. Conclusion: The results suggested that at present research, short-term exposure of PM2.5 can increase levels of FeNO, which suggested an increment of airway inflammation. FeNO may be a sensitive airway inflammation marker of air pollution.

**P03.1430. Long-Term Exposure to Ambient Air Pollution and Cognitive Function in Older U.S. Adults: The Multi-Ethnic Study of Atherosclerosis and Air Pollution**

Albert Presto

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**Abstract:** Background: On-road vehicles are a major source of air pollutant emissions. As a result, spatial patterns of air pollution near roadways have been studied exhaustively, and many spatial models such as land use regression (LUR) identify traffic as a main source of pollutant heterogeneity. However, relatively little is known about spatial patterns resulting from other common urban sources. Methods: We deployed an aerosol mass spectrometer (AMS), a state-of-the-art instrument for quantifying particulate matter (PM) composition, in a mobile laboratory. Measurements were conducted in Pittsburgh, PA and Oakland, CA. AMS provides real-time measurement of PM composition between organic and inorganic (sulfate, nitrate, ammonium) fractions, as well as full aerosol mass spectra of organic PM. Factor analysis of organic aerosol mass spectra allows for quantification of the contributions of both fresh emissions (e.g., traffic and cooking emissions) and aged secondary PM. Results: Urban spatial variations in PM exposure are dominated by fresh emissions, primarily from traffic and food cooking. Concentrations vary temporally, with higher traffic contributions in the morning and cooking dominating at midday and evening. In Pittsburgh, locations with both high traffic and high restaurant density have up to 2  $\mu\text{g m}^{-3}$  higher PM than the urban background. In Oakland, local traffic and cooking sources are more important than emissions from the large commercial port in driving pollutant spatial variations. Traffic also increases concentrations of secondary PM in downtown Oakland. The relationships between traffic- and cooking-emitted PM and typical land use variables is non-linear, which complicates the building of LUR models for source-specific PM. Conclusions: Source-resolved measurements of PM<sub>2.5</sub> reveal spatial patterns that cannot be described by traffic sources alone. Cooking is also an important determinant of PM<sub>2.5</sub> variations in US urban areas.

**P03.1440. Prenatal Exposure to PM2.5 in a Birth Cohort of Mexico City: The Influence of Season of the Year at Time of Conception**

Magali Hurtado-Díaz

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**Abstract:** Background. Due to well established relevance of season on air pollution assessment, we estimated prenatal PM<sub>2.5</sub> (particulate matter < 2.5 microns) exposure by season of the year at different gestational ages. Methods. 944 pregnant women were georeferenced by home addresses between 2007 and 2011 in Mexico City. Prenatal exposure to PM<sub>2.5</sub> was estimated using methods of (i) proximity; (ii) proximity with imputed data; and (iii) hybrid satellite model. Non parametric Wilcoxon signed-rank tests were used to compare exposure methods, and root mean square error to measure the magnitude of differences. Results. Average exposure to PM<sub>2.5</sub> during all pregnancy ranged from 20.4 to 22.9 µg/m<sup>3</sup> No differences were found between methods for assigning exposure ( $p < 0.05$ ). Pregnancies that started in cold-dry season had a higher average concentration throughout the gestation period (25.7 to 26.3 µg / m<sup>3</sup>) compared to pregnancies that started during the rainy season (18.1 to 19.7 µg / m<sup>3</sup>). Conclusion. Variations in prenatal exposure levels were attributed to seasonal differences and not to the methods for assessing exposure. These results provided information about how changes to exposure based on season of conception are relevant to adverse birth outcomes.

### **P03.1450. The Effect on Bacterial Growth and Antimicrobial Activity in the Airway from Exposure to Ambient and Indoor Air Particles**

Emma Stapleton

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**Abstract:** Human exposure to ambient air pollution causes a variety of cardiopulmonary health effects, including but not limited to upper respiratory tract infections, especially in susceptible populations. A byproduct of coal combustion, coal fly ash particulate matter, enhances bacterial growth in vitro, and decreases pulmonary antimicrobial activity ex vivo and in vitro. However, exposure to indoor air particles has not been studied. Bioluminescent *Staphylococcus aureus* was grown in minimal media with and without standard reference materials coal fly ash (CFA) and indoor air (IA) particles with an environmentally relevant dose of 10 and 50  $\mu\text{g}/\text{mL}$ . Bacterial growth increased significantly ( $p < 0.05$ ) after exposure to IA particles at two and three hours compared to vehicle control. To test the effect of particles on antimicrobial activity, we performed a bacterial challenge using airway surface liquid (ASL) from human donor cells. Immediate antimicrobial activity decreased in the presence of both CFA ( $p < 0.05$ ) and IA particles ( $p < 0.01$ ) at 50  $\mu\text{g}/\text{mL}$ , with a larger effect seen with IA particles ( $p < 0.01$ ). To verify whether the effect is limited to the large airway, we isolated ASL from pig cell cultures excised from small and large airways. In the large porcine ASL, IA particles had no effect at two different doses (50 and 100  $\mu\text{g}/\text{mL}$ ). However, CFA inhibited ASL killing at 100  $\mu\text{g}/\text{mL}$  ( $p < 0.05$ ). In the small airway, neither particle impaired ASL killing. Therefore, CFA inhibited ASL activity in large pig and human airway cells, and IA particles inhibited ASL activity only in human airway cells. These data suggest that exposure to indoor and ambient air particles do not impair ASL antimicrobial activity in the small airway; however, CFA and IA particles impair human ASL antimicrobial activity in the large airway. The data provide support for epidemiological findings of an increased rate of upper respiratory tract infections in populations exposed to ambient air pollution.

### **P03.1470. Disentangling Impacts of Multiple Nitrogen Dioxide Sources in an Urban Industrial Area**

Sheila Tripathy

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**Abstract:** Air pollution monitoring campaigns support policy development and health effects research. To our knowledge, however, there have been few such campaigns in Philadelphia, and none have been designed to comprehensively evaluate pollution levels across the entire city. As an industrial city with a variety of pollutant sources, Philadelphia is an important setting for such a targeted program. We developed a spatially saturated monitoring campaign to separate impacts of different sources of Nitrogen Dioxide (NO<sub>2</sub>) (e.g., traffic, port activity) throughout the city. NO<sub>2</sub> was monitored across Philadelphia for a two-week period (January 15th to January 29th, 2018) using Ogawa passive samplers. Samplers were placed 8-9 feet high on telephone poles. A total of 50 sites were selected. Selection methods varied, but were based on maximizing spatial variability in NO<sub>2</sub> concentrations. Thirty-two were selected using a stratified random sampling approach with geographic information system based indicators of traffic density, proximity to navigable riverways, and population density, all dichotomized at the 80th percentile. Fourteen sites were chosen at varying distances upwind and downwind of a petroleum refinery and the Philadelphia International Airport. Four reference sites were chosen--two in city parks, one in a suburb upwind of Philadelphia, and one within close proximity of an Air Quality System (AQS) regulatory monitor. The mean NO<sub>2</sub> concentration across all monitoring sites was 22.79 parts per billion (ppb) (SD=3.75 ppb, min=10.48 ppb, max=30.12 ppb). A subset of sites will continue to be monitored every two weeks throughout 2018. Concentrations will be modeled using land use regression models to predict concentrations at unmonitored locations. This data will be used in future epidemiologic studies of effects of air pollution and other urban exposures on adverse health outcomes, including pediatric asthma.

**P03.1490. Domestic Fires for Cooking, Burning of Waste, and Motor Vehicle Emissions as Risk Factors for Increased Morbidity in Abidjan, Ivory Coast**

Isabella Annesi-Maesano

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Abstract: Urban environments can harbor levels of air pollution threatening public health, outpacing other causes of death and creating elevated levels of disease. As city populations continue to rise, understanding urban pollutant concentrations becomes increasingly important and necessary for attributing contributions from specific urban activities, as well as in determining impacts on human health. Many studies relating negative health outcomes with poor air quality are focused on North America, Europe or China, and do not account for the specific weather patterns and rapid urban development of Western Africa, creating a gap in the understanding necessary to combat excess emissions. As part of the DACCIWA (Dynamics-aerosol-chemistry-cloud interactions in West Africa) project, we focus on the relations of three primary sources - domestic fires for cooking, waste burning, as well as vehicle emissions - with specific morbidities by examining three different neighborhoods within the city of Abidjan, each characterized by one of these sources. We related hospital visits and admissions data from six different hospitals within Abidjan to measurements of PM<sub>2.5</sub> concentrations, for both the rainy and dry seasons, between mid-2015 to mid-2017, in order to understand the risks associated with excess exposure in a tropical, coastal, urban environment. Overall, 13,965 hospital visits, including 3,372 hospital admissions for 2016, were observed. Using Health Impact Analysis (HIA), we estimated that annual number of hospital visits could be reduced by between 3.6% for those living near a waste-burning site and 3.8% for those living near heavy traffic and up to 24.9% for those living near high levels of domestic fire emissions, by reducing annual PM<sub>2.5</sub> emissions to align with WHO standards. Our data support the need for protecting individuals by comprehensively reducing air pollutant emissions.

### **P03.1500. Transmissometer Measurement of Black Carbon Is Sensitive to Reference Filter Characteristics**

Sreekanth Vakacherla

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**Abstract:** Background: Black carbon (BC) aerosols are relevant to global climate and human health. Here we describe how reference filter characteristics can influence instrument-reported attenuation measurements (thereby BC estimates) using the OT21 (SootScan Optical Transmissometer, Magee Scientific, Berkeley, California, USA), which uses optical absorption. Objective: Quantify the sensitivity of OT21 attenuation measurements to reference filter characteristics and propose a correction. Methods: we used an OT21 to measure optical transmittance of aerosol-loaded filters (collected as part of the CHAI project, Hyderabad, India) relative to several reference (unexposed) filters at two wavelengths, corresponding to BC (880 nm, Infrared (IR)) and ultraviolet aerosols (370 nm, ultraviolet (UV)). Results: Instrument-reported sample attenuation varied with reference filter. For a given aerosol-loaded filter, instrument-reported attenuation was inversely related to reference-filter weight (e.g., higher instrument-reported for a sample measured against a lower-weight reference filter). This sensitivity can lead to substantial under- and over-estimation by the instrument (estimated mean absolute error:  $\sim 10$  and  $16$  ATN for IR and UV respectively). We report equations for correcting OT21 output, which allow use of any unexposed filter as the reference filter; application of equations reduced the error several-fold, to  $2$  and  $3$  ATN, respectively, for IR and UV ( $17\%$  and  $6\%$  errors, respectively).

### **P03.1520. Plasma CRP and Response to Radon and Black Carbon in COPD Patients**

Stephanie Grady

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**Abstract:** Introduction: Since radon (Rn) decay products are radioactive ultrafine particles that coagulate onto ambient particles, we hypothesize that Rn exposure may enhance effects of indoor pollution. Methods: Black carbon (BC) was measured up to 4 times over 12 months by reflectance in fine particle samples in homes of 85 COPD patients from 6 Massachusetts counties over a mean of 7.6 days. After indoor sampling, plasma C-reactive protein (CRP) was measured. Since current smokers and homes with major sources of BC were excluded, indoor BC was primarily of outdoor origin. County-specific Rn estimates were obtained from Berkeley National Laboratory estimates of living area annual averages (range 0.73-1.42 pCi/L). First, we estimated county-specific effects of BC on lnCRP, adjusting for season, age, BMI, diabetes, heart disease, race, temperature and relative humidity, and blood draw time using mixed effects models with a random intercept for each person. To assess whether county-specific BC effects varied by Rn, we regressed the county-specific BC effect estimates against Rn using inverse-variance weighting. To determine if other county level factors explained associations, we regressed county-specific BC estimates against county level measures of population density, % in poverty, % minority population, median household income, and education. Results: Median BC=0.19 µg/m<sup>3</sup> (IQR=0.22 µg/m<sup>3</sup>) over 285 observations. The effect of BC on lnCRP increased (p<0.0001) with greater county level concentrations of Rn. For every 0.5 pCi/L increase in county-average Rn, the BC effect (per IQR) increased by 0.23 (95% CI=0.20, 0.27) lnCRP (mg/L)/IQR. Other county level covariates did not display this pattern. Conclusions: County level Rn, but not county level sociodemographic factors, enhanced effects of indoor BC on plasma CRP in COPD patients. These observations suggest Rn may enhance the toxicity of indoor BC of outdoor origin.

### **P03.1530. Epidemiological Approaches to Morbidity Forecasting for Health Impact Assessment of Air Pollution**

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**Abstract:** Background: Forecasting future baseline morbidity rates is crucial to air pollution benefits assessment and disease burden analysis. Although numerous methods have been developed, no standard epidemiological approaches have been proposed. The purpose of this review is to provide an overview of available methods and examine sensitivity of forecasts to method selected. Methods: A literature search on morbidity forecasting was conducted using PubMed and Google Scholar. Sensitivity analyses were conducted using age-specific hospitalization rate data and population estimates. Results: Morbidity forecasting approaches can be grouped into standard regression models and dynamic microsimulation models. Regression models assume that predictor and dependent variables are uniformly correlated over time. However, this is not always the case. While the aging population is expected to increase morbidity, this may be partially offset by improved medical care and reduced exposures to risk factors like smoking. Dynamic microsimulation models have emerged as a reliable tool to address this evolution. The models simulate individuals' risks and health determinants, and consider alternative "what if" scenarios to accurately project health outcomes. Using a conventional forecasting method based on population age distribution and age-specific all-cause hospitalization rates in Canada, we found that the projected rate increased from 91 per 1,000 population in 2001-02 to 102 per 1,000 in 2015-16. Conversely, the observed rate in 2015-16 decreased to 84 per 1,000, indicating an overestimation of 20%. Results differ for specific causes of hospitalization. Several studies also found that neglecting demographic dynamics and using unadjusted age-expenditure profile could overestimate healthcare expenditure by between 10% and 20%. Conclusion: Demographic dynamics and other factors must be considered to ensure the accuracy of baseline morbidity projections in air pollution health impact assessment.

### **P03.1540. Quantification of the Burden of Disease Attributable to Nitrogen Dioxide Exposure in Germany**

Alexandra Schneider

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**Abstract:** Introduction: Epidemiological studies have shown associations of nitrogen dioxide (NO<sub>2</sub>) with numerous health outcomes. EU-wide air quality limit values for NO<sub>2</sub> are in place but regularly exceeded at measuring stations near roads in Germany. Therefore, a health risk assessment for the NO<sub>2</sub>-exposure of the German population was conducted. Methods: For 2007 to 2014, maps of the annual spatial 1\*1km<sup>2</sup> distribution of a population-weighted NO<sub>2</sub> concentration indicator were calculated. For three model regions a small scale assessment of the NO<sub>2</sub> exposure also considered concentrations in the higher resolved urban background and close to highly polluted street sections. A systematic literature search was performed to ascertain the current evidence on long-term health effects of NO<sub>2</sub> and to identify exposure-response-functions transferrable to Germany. The Environmental Burden of Disease-concept was applied to quantify the NO<sub>2</sub>-associated health risks for relevant outcomes. Results: The yearly mean background NO<sub>2</sub> slightly decreased from 13µg/m<sup>3</sup> in 2007 to 11.8µg/m<sup>3</sup> in 2014. Using a counterfactual value of 10µg/m<sup>3</sup>, 5,966 (95 %-confidence interval: 2,031 to 9,893) premature deaths and 49,726 (16,929 to 82,456) Years of Live Lost due to cardiovascular mortality attributable to NO<sub>2</sub> long-term exposure were estimated for 2014. Between 2007 and 2014 a decrease was observed for attributable premature deaths. The higher resolution of NO<sub>2</sub>-concentration for the three model regions led to a substantial increase in the estimated number of premature deaths due to cardiovascular disease by 40% to 165%. Discussion: The present estimates are based on NO<sub>2</sub> concentrations reflecting background exposure and thus underestimate the burden of disease. A better accuracy of the NO<sub>2</sub> exposure estimation accounting for the higher concentrations in urban areas close to traffic improves the burden of disease quantification and may enhance the distinction of health effects related to fine and ultrafine particles.

### **P03.1550. Governance of the Air in Bogotá: An Experience of Ecosystem Approach**

Luis Hernández

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**Abstract:** Introduction the Health Services participation in the monitoring air quality in Bogotá City is essential to guarantee quality of air governance; furthermore a direct communication channel is needed between citizens and Government. Currently Bogotá has 14 air monitoring stations and a Health Services Network organized in 4 sub-nets. The highest air pollutant is the PM 2.5, in Bogotá, mainly produced by the diesel automobile use. Objective Realize an Air Governance experience like an ecosystem strategy in Bogotá based on a model that allows not only citizen action to be visible, but also regional and national entities, in a differential way to achieve the air decontamination plans. Methodology The following governance strategies were applied whit the participation of University of Los Andes and Bogotá Health Secretary: A. Citizen capacities training in air pollution. b. Follow-up citizen of decontamination plans: identification of responsible sectors of the plan: mobility, industry, habitat and environmental sectors. Results In total 152 caregivers and 193 health professionals were trained in air governance, in Bogotá. An evaluation of knowledge, attitudes and practices in before-after training was carried out, 123 health professionals (63.7%) and 118 from community (77.6%), value  $p < 0.05$  indicated knowledge, attitudes and practices sufficiency to favor air governance. It is important to highlights that 60% were women. It was possible to establish 510 first level health services that show citizens the levels of air pollution; a 15% coverage equivalence. One (1) board to citizen control and monitoring was established for the air decontamination plans, which is visible on the web. Conclusion 1. Citizenship skills train is necessary in air quality improvement. 2. Air governance means making more visible the different responsibilities at the citizen level, health authorities, environmental authorities, but also Mobility and Habitat sectors in national and regional levels.

**P03.1560. Development, Application and Evaluation of Risk of Bias Criteria for Case-Crossover and Time-Series Studies of Air Pollution and Health**

Dave Stieb

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Abstract: Systematic review and meta-analysis methods are increasingly being applied to environmental health literature. However, these methods have not been routinely applied within the context of formal risk assessments, despite common aims and practices, including systematic identification, analysis and summary assessment of the weight of evidence linking exposures and outcomes. A particular gap in these practices is the availability of standardized criteria for assessing risk of bias in studies of environmental exposures, operationalized in a form that can be efficiently and reliably applied by reviewers / risk assessors to a potentially large number of primary studies. Building on the Navigation Guide systematic review methodology, we developed, applied and evaluated risk of bias criteria applicable to time series and case-crossover studies linking air pollution and cardiovascular and respiratory morbidity, operationalizing them in DistillerSRT systematic review software in the context of a systematic review of health effects of nitrogen dioxide. Risk of bias domains comprised: selection bias and generalizability, exposure assessment, confounding, outcome assessment, completeness of outcome data, selective outcome reporting, conflict of interest and other sources of bias. Risk of bias criteria were developed through literature review and expert consultation and evaluated with respect to content and face validity, inter-rater agreement and completion time. Our findings address the feasibility and reliability of our risk of bias criteria for time series and case-crossover studies linking air pollution and cardiovascular and respiratory morbidity. These criteria may provide a promising tool in the context of both systematic review and risk assessment. PROSPERO registration number CRD42018084497.

### **P03.1580. Short-Term Effects of Air Pollution on Cerebrovascular Diseases**

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**Abstract:** Background/Aim PM2.5 is well-known to increase cerebrovascular diseases. However, there is a paucity of studies for the Japanese population, especially for Tokyo residents. In this study, we examined the association between exposure to hourly PM2.5 levels and acute cerebrovascular diseases using records on emergency department (ED) visit in Tokyo, Japan. Methods We used data on emergency department visits through ambulance dispatch (n=1,361,302) in the entire Tokyo prefecture from 2015 to 2016. Variables include date and time of incidence, age, sex, occurrence location at the ku-level (approx. ward or city level), and symptom/cause of dispatch recorded by paramedics. We selected non-traumatic cerebrovascular incidents (n=45,748). The PM2.5 data were acquired from the nearest air quality monitoring station to the occurrence location. Then, they were linked with the ED visits based on occurrence date and time. The bi-directional case-crossover study design was applied to investigate the acute cerebrovascular events controlling for ambient temperature, humidity, and day of week. Results A 10 µg/m<sup>3</sup> increase in PM2.5 level at the same hour was associated with a 1.01% (95% CI: 0.37 to 1.65) increase in ED visit related to cerebrovascular diseases. A stronger association was found in people aged between 50 and 70 (1.55%, 95% CI: 0.34 to 2.77). The same increase in PM2.5 was also associated with an increase in stroke (0.87%, 95%CI: 0.16 to 1.60). Conclusions Exposure to higher levels of PM2.5 was associated with increased ED visits pertinent to acute cerebrovascular diseases.

### **P03.1590. Is Non-Linear Concentration-Response Function between Daily Mean O3 Concentration and Mortality Biased?**

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**Abstract:** Background: The linearity of concentration-response (C-R) function between ambient O3 concentration and mortality has been controversial. Previous reports of non-linear C-R function has been suspected to be biased from unmeasured confounders. The aim of the present analysis is to examine the C-R function between O3 concentration and mortality with instrumental-variable approach. Methods: We extracted data of hourly meteorology, hourly O3 concentration and daily non-accidental mortality in Seoul from 2001 to 2009. We divided the dataset into two, odd-number (training set) and even-number years (testing set). Using the training set, we constructed a prediction model with support vector regression estimating the daily variations of mean O3 concentration caused by sun irradiance, wind speed and direction, uncorrelated with temperature and temporal trend. Then we predicted variance of daily O3 from the testing set using the prediction model, thus creating an instrumental variable. We analyzed the association between the instrumental variable and daily mortality. We also analyzed the association according to the different ranges of daily mean O3 concentration. Result: The cross-validated R2 was 0.20 and 0.15 for the prediction model with training set and testing set, respectively. The instrumental variable was significantly and negatively associated with daily mortality ( $\beta=-0.0042$ , SE=0.0009, P<0.0001). The negative slope of the association diminished as the quartile increased and the slope became positive in the 4th quartile (O3>29.7 ppb). The interaction between quartiles and instrumental variable was significant (P=0.0485). The slope was negative under 30 ppb of daily O3 concentration ( $\beta=-0.0041$ , SE=0.0011, P=0.0001), but it was positive over 30 ppb ( $\beta=0.0012$ , SE=0.0022, P=0.6000). Conclusion: We observed unequal C-R function between ambient O3 concentration and mortality according to the different ranges of daily mean O3 concentration with instrumental-variable approach.

### **P03.1600. Incorporating Individual Trajectories and Daily Activities in the Analysis of Exposure to Traffic-Related Air Pollution**

Maryam Shekarrizfard

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**Abstract:** Traditional methods for evaluating population exposure generally ignore individual movements and only rely on a long-term average concentration at the home location. In this study, we evaluate individuals' mobility exposure to ultrafine particles (UFP), black carbon (BC) and noise which have been associated with pulmonary diseases, oxidative stress and functional disturbances. For this purpose, we assigned UFP, BC and noise predicted by land use regression models to trip and activity locations of individuals throughout the day. This approach is implemented in Toronto, Canada and highlights the advantages of the dynamic modelling of exposure compared to traditional methods. The comparison between at home exposure and daily mobility-based exposure reveals significant differences when relying on individuals' mobility compared to a daily average at the home location. We observed that mobility exposures were often more elevated than daily exposure at the home location. On average, individuals increased their UFP, BC and noise exposure by 11%, 6% and 9% while commuting and conducting activities out of home (compared to the daily concentration at home). We conclude that our proposed dynamic approach significantly improves the results of traditional methods that rely on a long-term average concentration at the home location and we shed light on the importance of using individual daily activities to understand exposure. In addition, we examined the effect of socio-economic characteristics and observed that exposure was more strongly associated with indicators that represent the mobility of individuals, such as age, employment status and transit pass ownership.

### **P03.1610. Short-Term Effects of Ambient Air Pollution on Cardiovascular Diseases and Respiratory Disease in Northern Vietnam**

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**Abstract:** Objectives: This study investigated the short-term effects ambient air pollution with hospital admissions due to respiratory diseases and cardiovascular diseases in three provinces in Northern Vietnam. Methods: Hospital records of residences living in three provinces Ha noi, Phu Tho and Quang Ninh (Northern Vietnam) from national and provinces hospitals were extracted. We also obtained hourly means of ambient air pollutants (PM10, PM2.5, PM1, NO2, SO2, CO and O3) and meteorological factors in each province. Quasi-Poisson models were used to estimate the association between outcomes and atmospheric pollutants, controlling for other factors such as meteorology, holiday and influenza epidemics in each province. Specified outcomes in the analyses are asthma, chronic bronchitis, stroke, ischemic heart diseases. Results: Most ambient air pollutants were associated with increases in daily hospital admission due to respiratory hospitalizations and cardiovascular diseases. The strongest effects had been found in nitrogen dioxide (NO2) for hospitalization due to stroke and pneumonia in all ages. For example, increments of an interquartile range in the four-day average (lag0-3) level of NO2 (25.3µg/m<sup>3</sup>) were associated with 2.3% (95%CI: 0.7% - 4.6%) and 6.1% (95% CI 2.5% to 9.8%) increase in daily counts of admissions for pneumonia and stroke in Hanoi, respectively. CO concentrations were negatively associated with daily hospitalization for asthma but positively with all other outcomes in all provinces. The findings indicated that the effects differ between age groups and seasons. Conclusion: The internal consistency of the results in three provinces with wide differences in pollution sources suggests that the association of ambient air pollutions and hospital admissions also applies to Vietnam. Though relative risks are small, the related burden is large, thus, further reductions in air pollution in Vietnam will provide large benefits.

### **P03.1630. Ambient Particulate Air Pollution and Circulating C-Reactive Protein Level: A Meta-Analysis**

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**Abstract:** Background: Ambient particulate air pollution is a major threat to the cardiovascular health of the population. Inflammation is an important component of the pathophysiological process linking air pollution and cardiovascular disease (CVD). A classical marker of inflammation-C-reactive protein (CRP), has been recognized as an independent predictor of CVD risk. Exposure to ambient air pollutants may cause systemic inflammatory response but the association with CRP has been inconsistently reported. Objectives: We aims to estimate the effects of short-term and long-term exposures to ambient particulate air pollution on circulating CRP based on previous epidemiological studies. Methods: A systematic literature search of the PubMed, Web of Science, Embase, Scopus databases for publications up to January 2018 was conducted for studies reporting the association between ambient particulate matters (PM<sub>2.5</sub>, PM<sub>10</sub>) and circulating CRP level. We performed meta-analysis for associations reported in individual studies using a random-effect model and evaluated the effect modification by major potential confounders. Results: This meta-analysis comprised 243,960 participants from 37 observational studies carried out worldwide. Long-term exposure to particulate air pollution was much strongly associated with CRP level than short-term exposure. A 10 µg/m<sup>3</sup> increase of short-term exposure to PM<sub>2.5</sub> and PM<sub>10</sub> is associated with increases of 0.78% (95% CI: 0.22-1.33%) and 0.26% (95% CI:-0.03%,0.55%) in CRP level, respectively; and a 10 µg/m<sup>3</sup> increase of long-term exposure to PM<sub>2.5</sub> and PM<sub>10</sub> is associated with much higher increases of 18.49% (95%CI: 8.50-28.49%) and 11.10% (95%CI: 2.73-19.45%) in CRP level, respectively. Studies in Europe and North America showed stronger PM-CRP associations than studies in Asia. Conclusion: Exposure to ambient particulate air pollution is associated with elevated circulating CRP level.

**P03.1640. Association of Long Term Exposure of Particulate Matter 2.5 (PM2.5) and Cardio-Metabolic Diseases (CMDs) in Low & Middle Income Countries (LMICs): Systematic Review**

Suganthi Jaganathan

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**Abstract:** Introduction: Numerous epidemiological studies indicated that high levels of particulate matter < 2.5 µm diameter (PM2.5) as a major risk factor for adverse cardiovascular effects on health. However, most of these studies have been conducted in high income countries (HICs), where average levels of PM2.5 are far less compared to LMICs and their socio-economic profile of the population, disease burden and PM speciation/composition are very different. We systematically reviewed the association of long term exposure to PM2.5 and cardio-metabolic diseases (CMDs) in LMICs. Methods: Multiple databases were searched for English articles with date limits until March 2018. For this review, we included studies investigating the association of long-term exposure to PM2.5 (defined as an annual average/average measure  $\geq$  3 days of PM2.5 exposure) and CMDs such as hospital admissions, prevalence and deaths due to CMDs, conducted in LMICs as defined by World Bank. Excluded studies which employed proxy measures for exposures, specific occupational groups, specific air pollution episodes and studies with poor quality as assessed by Cochrane risk of bias tool. Results: A total of 5567 unique articles were identified, of which 617 qualified for abstract screening and only 11 articles were included for full text review from eight countries (Brazil, Bulgaria, China, Ghana, India, Mexico, Russia and South Africa). With regards to outcome assessment, 2 studies evaluated hospital admissions & emergency room visits for CMDs, 5 studies on mortality, and 4 studies were on risk factors like blood pressure, obesity, etc. Largely a positive association between exposure to PM 2.5 and CMDs has been found. Diversity of air pollution measurement methods and health outcomes limited the ability to perform meta-analysis. Conclusion: Limited evidence on long-term exposure to PM 2.5 and CMDs in the LMIC context warrants long-term cohort studies to establish the association.

### **P03.1650. Ambient Air Pollution and Health Impact in China: A Review Based on Chinese Survey**

Guanghai Dong

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**Abstract:** Background/Aim For the exposure-effect relationship of air pollution with health effect is non-linear, and the air pollution levels in developed countries were usually low (PM<sub>2.5</sub> mostly below 40 µg/m<sup>3</sup>), the results from developed countries may be not suitable in China where PM<sub>2.5</sub> levels were usually more than 120 µg/m<sup>3</sup>. Methods and Results We summary the results of our studies as following: 1) Air Pollution and Lung Cancer: Based on a cohort study of Northern China which a total of 39,054 participants aged 40-89 years were followed from 1998-2009, ambient PM<sub>10</sub> was positively associated with lung cancer mortality (HR per each 10 µg/m<sup>3</sup> = 1.65, 95% CI, 1.52-1.80), which was much higher than the IARC report (HR=1.08, 95%CI:1.00-1.07). 2) Air Pollution and CVDs in Chinese: Based on a cross-sectional study of 24,845 participants aged 18-74 years old, from 33 communities in Northeastern Chinese Cities, the adjusted odds ratio for stroke increased by 1.16 (95% CI, 1.03-1.30) per 19 µg/ m<sup>3</sup> increase in PM<sub>10</sub>. The associations of air pollutants with blood pressure were much stronger in populations with prehypertension than in the hypertensives. Diabetes is the most sensitive indicators for the impact of air pollutants on human health. 3) Air Pollution and Respiratory Health in Children: Study on 31,049 Chinese children, ages 2-14 years old in Seven Northeastern Cities during 2008-2009 found that 10 µg/m<sup>3</sup> increase of PM<sub>10</sub> resulted to a 38% (OR=1.35; 95%CI: 1.04-1.79) risk excess for asthma in children. The increased odds of lung function impairment ranged from 5% (aOR=1.05; 95%CI: 1.01, 1.10) for FVC < 85% predicted per 46.3 mg/m<sup>3</sup> for O<sub>3</sub> to 81% (aOR=1.81; 95%CI: 1.44, 2.28) for FEV<sub>1</sub> < 85% predicted per 30.6 mg/m<sup>3</sup> for PM<sub>10</sub>. Conclusions All these studies may prove to be effective preventative measures that could save lives and improve its quality, while reducing the economic and public health burden that plagues China and other industrialized nations.

### **P03.1660. Short-Term Exposure to Ozone and All-Cause Mortality in 95 Highly-Populated Japanese Cities**

Takehiro Michikawa

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**Abstract:** Introduction In Japan, ambient concentrations of ozone have been rising in Japan over the past few decades. Ozone is a classical air pollutant, and adversely affects human health. Therefore, updated health effect assessment for ozone would be informative to the regulation of ambient ozone. We examined the effects of ozone on non-accidental mortality by using a time-stratified case-crossover approach. Methods From the Japanese Ministry of Health, Labour and Welfare, we received mortality data in highly-populated 95 cities throughout Japan between the fiscal years 2012 and 2014. Hourly measurements of ozone, which were measured at one ambient air monitoring station within each city, were collected from the National Institute for Environmental Studies' atmosphere environment database. We calculated the daily maximum 8-h concentrations of ozone. We applied a conditional logistic regression model to estimate the city-specific association between ozone exposure and mortality, and then performed a meta-analysis of city-specific effect estimates. Results Average ozone concentration across 95 cities was 42.3 ppb (standard deviation = 15.2). Ozone exposure was positively associated with total non-accidental mortality (pooled percentage increase for 10 ppb increase in ozone at lag0-2 = 0.5, 95% confidence interval (CI) = 0.2 to 0.7). However, after adjustment for exposure to fine particulate matter (PM<sub>2.5</sub>), there was no association (percentage increase = 0, 95% CI = -0.3 to 0.3). In the PM<sub>2.5</sub>-adjusted model, ozone exposure increased only the risk of cardiovascular mortality (percentage increase = 1.3, 95% CI = 0 to 2.7). Conclusions In this study, short-term exposure to ozone was not clearly associated with mortality, but somewhat health effects were suspected.

**P03.1670. Google Street View Car Measurements of Traffic Related Air Pollution within Neighborhoods and Stroke in a Population with Preexisting Cardiovascular Disease**

Ananya Roy

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**Abstract:** Background: An explosion of sensor technology allows for novel methods to assess long term exposures of Traffic Related Air Pollution (TRAP) at an unprecedented spatial resolution. Yet it is unknown if these highly resolved differences in street level TRAP and thus exposure differences between neighbors, are associated with clinical health outcomes. Objective: We explore the relationship between highly resolved spatial differences in TRAP and cardiovascular events among adults with prior cardiovascular disease (CVD) in Oakland CA. Methods: Sensors on Google Street View cars were used to measure and map annual day time median concentrations of nitrogen dioxide [NO<sub>2</sub>], nitric oxide [NO], and black carbon [BC] along 30 m road segments in Oakland, CA. These were linked to residential addresses of 1,810 adults with preexisting CVD living in the mapped areas, during 2010 to 2015, and members of Kaiser Permanente Northern California. We fit Cox proportional hazard models to estimate the relationship between air pollution exposures and time to first CVD event among those with preexisting CVD and estimated associations by elderly status while controlling for age, race, sex, BMI, smoking, socioeconomic status and comorbidities. Results: Among the 1,038 elderly with preexisting CVD (>65 yrs.) a 1 SD increase in NO<sub>2</sub> was associated with a 22% (95% confidence interval [CI] 3% to 44%) increase in stroke risk and a 4% (95% CI -6% to 16%) change in risk of any CVD event. Associations with NO were similar while associations with BC exposure were generally weaker. Among the 772 non-elderly adult population with preexisting CVD, most associations were weaker and not statistically significant. . Conclusion: Long term differences in NO<sub>2</sub> exposures between neighbors are associated with differences in stroke risks among the elderly who have preexisting CVD.

### **P03.1680. Impact of the Exposure to Traffic-Related Air Pollutants during Commuting by Foot on Children's Cognitive Development**

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Abstract: Air pollution is suspected to have an effect on cognitive functions. Within the BREATHE project, we found that long-term exposure to traffic-related air pollutants (TRAPs) at school was linked to a lower cognitive development. Due to the proximity to the source, although commuting may be a relatively small amount of time, children may receive a high proportion of the daily TRAP. In a BREATHE subpopulation of 45 children, commuting corresponded to 6% of the time, but 20% of the Black Carbon (BC) daily dose. Despite the dose intensity of commutes, its impacts on neurodevelopment have not been studied. We aimed to assess the role of the exposure to TRAPs during the commute to school on cognitive development of schoolchildren. We carried out a longitudinal study including children from 39 schools in Barcelona (Catalonia, Spain) who commuted by foot to school (n=1,234). The children performed 4 computerized tests during 1 year follow-up to assess their developmental trajectories in WM (3-back numbers test) and inattentiveness. Average particulate matter  $\leq 2.5 \mu\text{m}$  (PM2.5), BC, and NO<sub>2</sub> concentrations were estimated for the shortest walking route by Land Use Regression. Differences in cognitive growth were evaluated with linear mixed effects models with age-by-pollutant interaction terms. An interquartile range (IQR) increase in PM2.5 concentration was associated with a reduction in WM of 5.4 (95%CI [-10.2,-0.6]) points. Similarly, for BC the reduction in WM was 4.6 (95%CI [-9.0,-0.1]) points. Findings for NO<sub>2</sub> were not conclusive. We found an increase in inattentiveness, although the association was not significant for any of the pollutants. The effects were independent to the exposure at home and at school. Exposures to PM2.5 and BC from commutes by foot were associated with a reduction in the growth of WM. The design and implantation of pedestrian school pathways through low traffic streets is encouraged in order to increase security and minimise children's exposure to TRAPs.

**P03.1690. Effects of Air Pollution and Land Use Characteristics on Development and Respiratory Health among Children in the Greater Taipei Area**

Hsing Chao

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Abstract: Indoor and outdoor air pollution poses an important health threat to children. Exposure to air pollution may cause various acute and chronic respiratory diseases, and affect neurodevelopment and cognitive functions in children. To evaluate the impact of air pollution on children's health, we conduct a study to examine the effect of prenatal and early childhood exposure to air pollution on development and respiratory health in the first 3 years of life among a birth cohort in the Greater Taipei area. We will recruit 500 cohort children, and evaluate their development and respiratory diseases using standardized questionnaires and Bayley Scales of Infant and Toddler Development. One hundred children will be selected to conduct indoor and outdoor environmental samplings of their residences. Four hundred and fifty-six cohort children have been recruited so far, and environmental measurements have been implemented in 40 homes. According to our analyses, most ambient pollutant concentrations near participants' homes were lower than Taiwan National Ambient Air Quality Standard, except PM<sub>2.5</sub>, which exceeded the annual average level (15µg/m<sup>3</sup>). A few households had elevated indoor pollution levels due to a low ventilation rate or recent remodeling. Several children's bed dust samples contained dust mite allergen levels > 2 µg/g, which may increase the risk of child sensitization to dust mites. According to multiple regression analyses, a high level of nitrogen oxides during first trimester near residence as well as living near gas stations, social welfare facilities, or high ways had adverse effects on children's health; living near green parks was beneficial to children's neurodevelopment. Overall, residential environments, such as air quality and land use type nearby, may significantly influence children's health and neurodevelopment.

### **P03.1700. Exposure to Ambient Air Pollutants and the Onset of Dementia: An Administrative Cohort Study in Québec**

Audrey Smargiassi

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Abstract: Effects of air pollutants are related to oxidative stress which is also linked to the pathogenesis of dementia including Alzheimer's and associated diseases. We assessed associations between exposure to air pollutants and the onset of dementia; the association with the distance to major roads was also assessed for the island of Montreal. We created an open cohort of adults aged 65 years and older starting in 2000 in the province of Québec, Canada using linked medico-administrative databases. New cases of dementia were defined based on a validated algorithm. Annual residential levels of nitrogen dioxide (NO<sub>2</sub>) and fine particles (PM<sub>2.5</sub>) residential levels were estimated for each year of follow up using estimates based on satellite images and ground data. Hazard ratios (HRs) were assessed with Cox models with age as the time axis and stratified for sex, for the exposure at address at entry. Models were adjusted for the year, area-wide social and material deprivation indexes and for NO<sub>2</sub> or PM<sub>2.5</sub>; they were also indirectly adjusted for smoking. 1,807,133 persons (13,322,480 person-years) were followed and 237,569 developed dementia. HRs from adjusted models for an interquartile range increase in exposure at entry to NO<sub>2</sub> (15.49 ppb), PM<sub>2.5</sub> (4.67 µg/m<sup>3</sup>), and distance to major roads (147 m), were 1.015 (CI 95% 1.005-1.024), 1.021 (CI 95% 1.010-1.032) and 0.979 (CI 95% 0.967-0.990), respectively. Results suggest that the onset of dementia may be related to residential exposure to PM<sub>2.5</sub>, NO<sub>2</sub>, and distance to major roads. Acknowledgments: This work was supported by a Memorandum of Agreement with Health Canada.

### **P03.1710. Association of Particulate Matter Exposure and Depression: A Systematic Review and Meta-Analysis**

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**Abstract:** Background Impact of particulate matter (PM) air pollution exposure and mental health conditions is generating lot of curiosity among public health practitioners and policy makers. We aimed to generate evidence on daily PM<sub>2.5</sub> and PM<sub>10</sub> exposure and depression. Methods A systematic search was conducted for published studies in English till December 2017. Independent two electronic searches were carried out in Medline, Web of Science and Cochrane Library using key words "Airborne Particulate Matter" OR "Air Pollutants" OR "Air Quality", "Outdoor Air Pollution" "PM<sub>2.5</sub>" "PM<sub>10</sub>" " Depression" "Depressive symptoms" "Mood disorder." We used Medical Subject Headings (MeSH) terms: "Particulate matter" and "Depression" in Medline and Cochrane Search. We have included articles reporting adjusted relative risk (RR) or odds ratio (OR) PM exposure and depression. References of the selected articles were also traced. Meta-analysis was performed to calculate pooled estimate using fixed effect model. Quality of studies was assessed using Newcastle-Ottawa Scale for observational studies. Protocol of the systematic review was registered in PROSPERO. Results We have got 938 records from all searched databases. Of which, 14 records were included for full text review after screening abstract and removing duplicates. Finally, eight articles were included for meta-analysis. Most of studies were longitudinal studies and spread out geographically across the regions. Daily PM<sub>2.5</sub> exposure was found to be associated with depression (RR=1.08, 95 CI: 1.02, 1.14) with acceptable heterogeneity (I<sup>2</sup>: 56%). Daily PM<sub>10</sub> exposure was not found to be associated with depression (RR = 1.01, 95% CI: 0.97,1.04). Age, sex, household income, education, co-morbidity and road traffic noise were adjusted as confounders. Conclusion We have found modest strength of association for daily PM<sub>2.5</sub> exposure and depression. Unknown confounders might have affected the pooled estimate from longitudinal studies in our analysis.

**P03.1720. Ambient Air Pollution and Completed Suicide in 26 South Korean Cities: Effect Modification by Demographic and Socioeconomic Factors**

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Abstract: Air pollution has been associated with suicide mortality. However, limited studies have examined possible effect modification of the association by various demographic and socioeconomic factors, despite their crucial roles on suicide risk. In 73,445 completed suicide cases from 26 South Korean cities from 2002-2013, we studied the association of suicide risk with exposure to particles <10  $\mu\text{m}$  (PM10), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), and carbon monoxide (CO), using a city-specific conditional logistic regression analysis with a case-crossover design. Random effects meta-analysis pooled the results. We considered a delayed effect of air pollution by constructing lags up to 7 days. We explored effect modification by demographic and socioeconomic factors (sex, age, education level, job, and marital status) as well as place of death, method of suicide, and season, through stratified subgroup analyses. Among five pollutants, NO<sub>2</sub> showed the strongest association at immediate lags (percent change in odds ratio; PM10: 1.2% [95% CI, 0.2%, 2.3%]; NO<sub>2</sub>: 4.3% [95% CI, 1.9%, 6.7%]; SO<sub>2</sub>: 2.2% [95% CI, 0.7%, 3.8%]; O<sub>3</sub>: 1.5% [95% CI, -0.3%, 3.2%]; and CO: 2.4% [95% CI, 0.9%, 3.8%] per interquartile range increase at lag0). In subgroup analyses by socioeconomic factors, stronger associations were observed in the male sex, the elderly, those with lower education status, white-collar workers, and the married; the largest association was an 11.0% increase (95% CI, 4.1%, 18.4%) by NO<sub>2</sub> among white-collar workers. We add evidence of effect modification of the association between air pollution exposure and suicide risk by various demographic and socioeconomic factors. These findings can serve as the basis for suicide prevention strategies by providing information regarding susceptible subgroups.

**P03.1750. Source Specific Air Pollution's Link to Hospitalizations and Emergency Department Visits for Influenza or Bacterial Pneumonia in Adults: The New York State Accountability Study**

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Abstract: Fine particulate air pollution (PM<sub>2.5</sub>) has been linked to respiratory infections including influenza and bacterial pneumonia, but the response of respiratory infections to source specific PM concentrations (e.g. traffic, wood smoke) remains an area of active research. Using source specific PM<sub>2.5</sub> concentrations generated from Positive Matrix Factorization analyses at 6 urban sites in New York State (Buffalo, Rochester, Albany, Queens, Bronx, and Manhattan), we examined the association between source specific pollutants and the excess rate (ER) of hospitalizations and emergency department (ED) visits for influenza or bacterial pneumonia. We retrieved all hospital admissions and ED visits with a primary diagnosis of influenza or bacterial pneumonia from 2005 to 2016 from the Statewide Planning and Research Cooperative System (SPARCS) database. Using a case-crossover design and conditional logistic regression, we estimated the rate of influenza or bacterial pneumonia (for both hospitalizations and ED visits) associated with increased concentrations of source specific PM<sub>2.5</sub> including ammonium sulfate (AS), ammonium nitrate (AN), biomass burning (BB), pyrolyzed organic carbon (OP), road dust (RD), diesel (DES) and spark-ignition (GAS) vehicles. In preliminary analyses, interquartile range increases (IQR) in GAS concentrations in the previous 3 days were associated with an increased rate of influenza hospitalizations (ER = 13.8%; 95% CI: 5.4, 22.9) and ED visits (ER = 13.4%; 95% CI: 6.4, 20.8) with similar findings for DES and AN in both care settings. The association between bacterial pneumonia and source specific PM was inconsistent, with unexpected findings of reduced bacterial pneumonia hospitalizations associated with increases in both OP and DES, but increased ED visits associated with increases in RD. Future analyses will adjust for PM<sub>2.5</sub> mass, but increases in secondary PM<sub>2.5</sub> appear to be associated with an increased rate of influenza but not bacterial pneumonia.

**P03.1760. Epidemiological Study of PM2.5 and Its Chemical Constituents in a Small Residential City in Korea**

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Abstract: PM2.5, defined as particles less than 2.5  $\mu\text{m}$  has been a great concern due to its significant adverse health effects, causing mostly respiratory and cardiovascular diseases. In Korea, PM2.5 concentration often exceeds the National Ambient Air Quality Standard of Korea as well as the WHO standard. PM2.5 concentrations in rural areas and even in background areas are often comparable with those measured in urban and industrial areas in Korea, indicating that long-range transport from regional sources may be important; however, most studies have been conducted in urban areas. In this study, the atmospheric concentrations of PM2.5 and its chemical constituents were measured in a small residential city of Korea from 2006 to 2012, and the association between PM2.5 and COPD-related hospital visits was evaluated. Data on hospital visits including admission and outpatient clinic visits for exacerbation of COPD were extracted from the National Health Insurance Service database. The average PM2.5 concentration was  $35.0 \pm 25.2 \mu\text{g}/\text{m}^3$  during the sampling period, and the number of daily hospital visits were  $6.42 \pm 4.28$  and  $2.07 \pm 1.93$  for males and females, respectively. The number of COPD-related hospital visits increased as PM2.5 increased. PM2.5 constituents including Al, Si, and elemental carbon were significantly associated with increased hospital visits. In the conference, the temporal trend and major characteristics of PM2.5 and its chemical constituents will be discussed in detail, along with an association between PM2.5 and the risk of COPE-related hospital visits.

**P03.1770. An Exploratory Analysis of the Effect of Regulatory Policies for Pre-Harvesting Sugarcane Straw Burning on Hospital Admissions for Respiratory Diseases in the State of São Paulo, Brazil**

Agnes Soares da Silva

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Abstract: Emissions generated by sugarcane burning have been associated with acute respiratory effects and increase in hospital admissions, among other health effects. In 2002 the State of São Paulo (SP) approved a law that was adopted in 2003 that foresees the elimination of the practice of pre-harvesting sugarcane burn progressively up to the year 2031. This process has been accelerated through voluntary protocol agreements between the State and the producers, with incentives provided by the State, and pre-harvest sugarcane straw burn could have been eliminated in 2017. We analysed the trends in annual rates of hospital admissions for respiratory diseases in cities with the highest sugarcane plantations areas in the period 2000-2017. Data from hospitalization were obtained from the Hospital Information System (SIH/SUS) for respiratory diseases (J40, J44-47). Data from population were obtained from the Brazilian Institute of Geographic Statistics. Hospitalization rates were calculated for general population. To estimate sugar-cane plantation areas data, enhanced vegetation index from MODIS MOQ13 images was used. Ten cities with the largest plantation areas were selected. Data for pre-harvesting sugarcane burn were obtained from Spatial Research Institute and only the burns occurred in the sugar-cane plantation areas were included. All datasets were for the period 2000-2017. Trends in hospitalizations rates for all study cities were assessed by Prains-Winsten regression models. The time-series of pre-harvesting sugarcane burn, sugarcane plantation areas, and hospitalization rates did not present any trend ( $p>0.05$ ) in the study period. These preliminary results showed that legal measures to eliminate pre-harvesting sugarcane burn were not effective in any study city. Moreover, the period coincides with an expansion of the sugarcane plantation areas in São Paulo State. Thus, legal and voluntary measures have not proved to be sufficient to protect public health in the study area.

### **P03.1780. Effects of Particulate Air Pollution on Pulmonary Function among Healthy Students**

Yoshiko Yoda

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**Abstract:** Background: Many epidemiological studies have reported that particulate air pollution was associated with exacerbation of respiratory diseases such as asthma. However, evidence about short-term effects of air pollution in healthy people is limited. We evaluated the effects of particulate air pollution on pulmonary function among healthy students in Japan twice a year for 3 years. Methods: A panel study was conducted of 48 healthy students who attended a school in an isolated island in the Seto Inland Sea, Japan. Peak expiratory flow (PEF) and forced expiratory volume in 1 s (FEV1) were repeatedly measured in every morning for each one month in spring and autumn from 2014 to 2016. Ambient concentrations of fine (PM<sub>2.5</sub>) and coarse (PM<sub>10-2.5</sub>) particulate matter and black carbon (BC) were measured on the roof of the school during the study period. Mixed-effects models were used to evaluate the associations of PEF and FEV1 with the average concentrations of air pollutants during the 24 h before a pulmonary function test. Results: The mean (SD) concentrations of PM<sub>2.5</sub>, PM<sub>10-2.5</sub> and BC were 23.5 (10.8), 15.3 (8.4) and 0.49 (0.28) µg/m<sup>3</sup>. Significant decreases in PEF were associated with PM<sub>2.5</sub> (-1.34% [95% confidence interval (CI): -1.88, -0.80] for an interquartile range (IQR) increase of 14.1 µg/m<sup>3</sup>) and BC (-1.02% [95%CI: -1.54, -0.50] for an IQR increase of 0.40 µg/m<sup>3</sup>). The decreases in FEV1 were also significantly associated with the increase in PM<sub>2.5</sub> and BC (-1.32% [95%CI: -1.99, -0.66] and -0.67% [95%CI: -1.32, -0.02], respectively). In seasonal analyses, the both effects of PM<sub>2.5</sub> and BC on pulmonary functions were significant in autumn. However, neither effects were significant in spring. No significant relationship between PM<sub>10-2.5</sub> and pulmonary function was observed throughout the study period. Conclusions: These results showed the effects of PM<sub>2.5</sub> and BC on pulmonary function among healthy students at considerably low levels.

**P03.1790. Air Pollution and the Burden of Childhood Asthma in the Contiguous United States in 2000 and 2010**

Haneen Khreis

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**Abstract:** Background Emerging evidence suggests that traffic-related air pollution (TRAP) is associated with childhood asthma. However, no studies have estimated the burden of childhood asthma attributable to TRAP for the United States. We aimed to estimate the number of incident childhood asthma cases attributable to Nitrogen Dioxide (NO<sub>2</sub>) - a good marker of TRAP - in the Contiguous U.S. for the years 2000 and 2010. Methods Using a published national regression model, we estimated NO<sub>2</sub> exposures at the centroid of each U.S. Census Block and assigned that exposure to all children (birth - 18 years old) living in that Block. From the literature, we extracted a national average asthma incidence rate of 12.5 per 1,000 at-risk children/year and a concentration-response function of 1.05 (95% CI = 1.02, 1.07) per 4 µg/m<sup>3</sup> NO<sub>2</sub>. We calculated the relative risk, population attributable fraction and number of childhood asthma cases attributable to NO<sub>2</sub> exposures at each Census Block using a standard burden of disease assessment framework. We summed the attributable number of childhood asthma cases across the Contiguous U.S. Results NO<sub>2</sub> accounted for 209,058 (27%) incident cases of childhood asthma in 2000 and 141,931 (18%) in 2010. The reduction of cases was mainly due to a documented reduction in average NO<sub>2</sub> concentrations between 2000 and 2010 (18.7 µg/m<sup>3</sup> to 11.9 µg/m<sup>3</sup>). In current work, we are repeating this analysis with state-specific asthma incidence rates and with exposure to other pollutants including PM<sub>2.5</sub> and PM<sub>10</sub>. Conclusion A considerable proportion of new childhood asthma cases are attributable to NO<sub>2</sub> in the Contiguous U.S. We expect that TRAP-related cases would be preventable if TRAP emissions were reduced.

### **P03.1800. Ambient Air Pollution and Respiratory Diseases in Children in Jefferson County, Alabama**

Meghan Tipre

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**Abstract:** Introduction. Environmental air pollution is an important contributor to the global burden of respiratory disease among children. We examined the effects of PM<sub>10</sub>, ozone, PM<sub>2.5</sub> and its speciated compounds, on emergency department (ED) visits for respiratory diseases (RDs) among children, in Jefferson County (JC), Alabama. Methods. Daily exposure to air pollutants was characterized as county-wide aggregate and by residential zip codes. Daily counts of ED admissions for RDs, upper respiratory infections (URI) and asthma in children below 18 years of age were obtained from eight hospitals in JC. We used generalized additive model to evaluate associations, adjusting for seasonal and temporal trends, temperature, relative humidity, day of the week and age. Additionally, we used lagged models and stratification by seasons. Results. Using zip-code specific exposure, we found statistically significant positive associations between PM<sub>10</sub> and all RDs (RR, 1.003; 95%CI, 1.002 - 1.003), URI (RR, 1.002; 95%CI, 1.001 - 1.003) and asthma (RR, 1.005; 95%CI, 1.004 - 1.006), and between PM<sub>2.5</sub> and all RDs (RR, 1.002; 95% CI, 1.001 - 1.003), URI (RR, 1.001; 95%CI, 1.000 - 1.003), and asthma (RR, 1.003; 95%CI, 1.002 - 1.005). Similarly, significant positive association was noted for speciated pollutants, CO, EC, MMO, NH<sub>4</sub> NO<sub>3</sub>, OC, SO<sub>2</sub>, SO<sub>4</sub>, and TC pollutants and RDs, URI and asthma. Inconsistent associations were noted between ozone and all RDs. In lagged analyses, 0-2 days, 0-5 days, and 0-8 days moving-average lagged exposure had stronger association with disease outcomes compared to same day and single-day lagged exposure. No associations were noted between county-wide average PM<sub>2.5</sub>, PM<sub>10</sub>, and ozone, and RDs. Conclusion. Our results suggest that short-term exposures to PM and speciated pollutants may account for increased risk of paediatric ED visits for RDs. It may be optimal to characterize personal exposure within small units such as zip-codes compared to county-wide exposures.

### **P03.1820. Association between Household Solid Fuel Use and the Height of Children in China**

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Abstract: Household air pollution from solid fuel combustion is one top environmental risk factor for many diseases and premature deaths, but few studies investigated postnatal exposure impacts of solid fuel use on children height. This study is to test the hypothesis that whether children from households using solid fuels are shorter than those using clean fuels. Heights of 59,112 children aged 1-17 years old are compared between the solid fuel and clean fuel groups with generalized linear models, adjusting for important risk factors including household income, second-hand smoke exposure, nutrition, education and occupations of parents. Significantly lower heights are observed for children living in households using traditional solid fuels for cooking during childhood, in line with prenatal exposure, which calls for effective and urgent actions on clean fuel interventions. Future mechanism studies are interesting.

### **P03.1830. Outdoor Air Pollution and Lung Function in Middle-Aged Adults of the ELISABET Study**

Anaïs Havet

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**Abstract:** The impact of long-term exposure to outdoor air pollution on lung function remains insufficiently studied in adults. Our aim was to study the associations between long-term exposure to outdoor air pollution, including industrial and urban exposures, and lung function in middle-aged adults. The analyses were conducted among 2994 adults (53 years old in average, 47% men) from the Enquête Littoral Souffle Air Biologie Environment (ELISABET, 2011-2013), a French cross-sectional survey. Air pollutant levels (NO<sub>2</sub>, PM<sub>10</sub> and SO<sub>2</sub>) were estimated at the participants' residential address by ATMO Nord-Pas-de-Calais, in Lille and Dunkirk urban areas. The lung function tests were performed according to the ATS/ERS guidelines, and FEV<sub>1</sub> (Forced Expiratory Volume in one second), FVC (Forced Vital Capacity), FEV<sub>1</sub>/FVC ratio and FEF<sub>25-75</sub> (Forced Expiratory Flow between 25 and 75% of the FVC) were used. Linear regression models adjusted for age, sex, height, year of inclusion, center, investigator, smoking status, body mass index, educational level and occupational exposure to dusts and fumes were conducted. An increase of 5 µg/m<sup>3</sup> in NO<sub>2</sub> was associated with lower FEV<sub>1</sub> (-1.37%, 95%CI -2.05 to -0.69), lower FVC (-0.84%, 95%CI -1.45 to -0.23), lower FEV<sub>1</sub>/FVC (-0.47%, 95%CI -0.77 to -0.17) and lower FEF<sub>25-75</sub> (-2.71%, 95%CI -4.20 to -1.21). An increase of 2 µg/m<sup>3</sup> in PM<sub>10</sub> was associated with lower FEV<sub>1</sub> (-1.31%, 95%CI -2.06 to -0.55), lower FVC (-0.81%, 95%CI -1.49 to -0.13), lower FEV<sub>1</sub>/FVC (-0.43%, 95%CI -0.77 to -0.10) and lower FEF<sub>25-75</sub> (-2.44%, 95%CI -4.10 to -0.78). An increase of 2 µg/m<sup>3</sup> in SO<sub>2</sub> was associated with lower FEV<sub>1</sub> (-1.33%, 95%CI -2.27 to -0.39), lower FEV<sub>1</sub>/FVC (-0.52%, 95%CI -0.92 to -0.11), lower FEF<sub>25-75</sub> (-2.70%, 95%CI -4.82 to -0.59), but was not significantly associated with lower FVC (-0.77%, 95%CI -1.62 to 0.09). Our results add evidence of the impact of urban and industrial outdoor air pollution on lung function in adults from northern France.

**P03.1840. Association of Biomass Fuel Use with Reduced Body Weight of Adult Ghanaian Women: Is it an Example of Reverse Causality?**

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**Abstract:** Background: Smoking and ambient air pollution have been associated with body weight. Yet, the association of biomass fuel use with body weight has never been investigated in spite of the combustion pollutants sharing similar constituents with these environmental exposures. Objectives: We therefore examined the effect of biomass fuel use on body weight of adult women to provide insight into the obesity epidemic in Ghana and other sub-Saharan African countries. Methods: Data from the 2014 Ghana Demographic and Health Survey, a nationally representative population-based survey was analysed for this study. A total of 4,751 women who had anthropometric (height and weight) data qualified for inclusion in this study. Results: In linear regression modelling, use of charcoal resulted in 3.08 kg (95% CI: 2.04, 4.12) and 0.81 kg/m<sup>2</sup> (95% CI: 0.29, 1.33) reduction in weight and BMI, respectively. Use of wood also resulted in 7.77 kg (95% CI: 6.34, 9.20) and 2.49 kg/m<sup>2</sup> (95% CI: 1.77, 3.21) reduction in weight and BMI, respectively. In modified Poisson regression with logarithmic function, charcoal users had 19% (Adjusted Prevalence Ratio [aPR] = 0.81; 95%CI: 0.71, 0.92) and 29% (aPR = 0.71; 95%CI: 0.61, 0.83) decreased risk of overweight and obesity, respectively. Wood users had 37% (aPR = 0.63; 95%CI: 0.51, 0.78) and 61% (aPR = 0.39; 95%CI: 0.29, 0.52) decreased risk of overweight and obesity, respectively. Conclusions: The association of biomass fuel use with reduced body weight and BMI of Ghanaian women observed possibly reflects reverse causality from the weight loss triggering correlates of poor socioeconomic status. Elucidating the causal mechanisms through rigorous study designs is important to understanding the policy relevance of our findings.

### **P03.1850. PM2.5 Concentrations in Various Microenvironments and Exposure Prediction for Elderly Population**

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Abstract: This study was to investigate PM2.5 concentrations for various microenvironments indoor and outdoor in a city, north Taiwan. Personal PM2.5 exposure for elderly population was also predicted using a microenvironmental exposure (ME) model. More than 200 places and locations divided into 23 microenvironments by indoor, outdoor and transit modes were selected. A real-time monitor (SidePak, TSI Model AM510) was used to measure PM2.5 mass concentration (5-min interval) in each location for two hours at least in the warm and cold seasons during 2015-2017. The same type of the aerosol monitor was situated at the nearby air quality monitoring stations of the Taiwan EPA to simultaneously monitor ambient PM2.5. The results of the ME model, combining ambient/outdoor PM2.5, personal activity diaries, and microenvironment PM2.5 information, were validated with personal PM2.5 monitoring data. For indoor microenvironment, the restaurant and temple presented the highest concentration of PM2.5. For outdoor location, the traditional market and night market with relatively higher levels of PM2.5 were also observed. Riding a motorcycle could result in a higher PM2.5 exposure among transit activities. Considering personal time-activity patterns and time-weighted concentrations of PM2.5 in the microenvironments, we found home indoor exposure (90.2%) mainly attributed to total daily PM2.5 exposure for elderly, followed by transit (5.01%), other indoor (2.97%) and outdoor (1.81%) exposures. The model prediction performed well ( $R^2 = 0.83$ ) when outdoor PM2.5 was used as a surrogate compared with typically used ambient PM2.5 ( $R^2 = 0.64$ ).

### **P03.1860. Hazardous Emissions from the Partial Combustion of Aircraft Fluids**

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Abstract: Smoke events aboard aircraft occur in both commercial and military sectors and can potentially lead to health effects. In the event of a system failure, aircraft fluids can partially combust, and the emissions can enter the cabin through engine bleed air, exposing aircrew and passengers. In this study, five aircraft fluids were heated and burned in a cone calorimeter, and the emissions were characterized using a suite of aerosol and gas detection instruments. Real-time aerosol monitoring showed a high concentration of ultrafine particulate matter during the combustion process, while real-time gas monitoring showed elevated concentrations of carbon monoxide and hydrogen cyanide. Offline analysis of collected volatile organic compounds using gas chromatography–mass spectrometry revealed several potentially hazardous chemicals. Offline analysis of collected particles using transmission electron microscopy–energy dispersive X-ray spectroscopy resulted in observations of amorphous carbon chains, indicative of partial combustion. These results indicate that the partially combusted aircraft fluids tested could pose a health risk to those exposed to the emissions. Further, understanding the unique emission characteristics for different common aircraft fluids can help response personnel in tracking the origin of smoke events to system failures.

### **P03.1870. A Spatio-Temporal Prediction Model for Black Carbon Based on Automated Machine Learning**

Yara Abu Awad

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**Abstract:** There is increasing evidence for the health effects of particles from transportation sources, with black carbon (BC) in particular gaining attention. The high spatial and temporal variation of exposure on a small scale can make the effects of this pollutant difficult to study. We previously fit a model using the machine learning (ML) methods support vector regression and simple gradient boosting to predict daily BC concentrations in Massachusetts, Rhode Island and southern New Hampshire. However, this model only went up to 2012 and while it did use ML methods, there have been significant advances in the ML field that can produce even better prediction models. We used automated machine learning (AutoML) which is a powerful and fast tool that can rescale data and then blend up to 15 ML algorithms in order to generate predictions. AutoML also carries out Bayesian hyperparameter tuning and iteratively improves with longer runtime. A total of 49,263 BC measurements from 371 monitors over a 16 year period (2000 to 2015) were obtained from various sources and calibrated for consistency. Both land use and temporal predictors were deployed, which allowed us to capture changes in spatial patterns of BC over time. We then input our data into the auto-sklearn package in python 3 and allowed it to run over 7 hours. The model showed good accuracy with an R2 of 0.80 in the held-out test data. We have successfully built a model that can be used to estimate long-term and daily exposures to ambient BC and will be useful for research looking at various health outcomes in MA, RI and Southern NH.

### **P03.1880. Endotoxin Concentrations in Airborne Particulate Matter and House Dust in Homes of Japanese Children**

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**Abstract:** Background: Endotoxins are an important biological component of particulate matter, and have been associated with adverse effects on human health. Many previous studies have evaluated endotoxin concentrations in house dust in the homes. However, there is no consensus on the association between airborne and dust endotoxin concentrations. Methods: We collected fine (PM<sub>2.5</sub>) and coarse (PM<sub>10-2.5</sub>) particulate matter for 7 days, inside and outside 287 homes of children who participated in the Japan Environment and Children's Study (JECS), from October 2015 to August 2017. In addition, dust samples were collected from mattress of the children. Endotoxin in both fractions of particulate matters and dust samples were measured using the kinetic Limulus Amebocyte Lysate assay. The relationships between endotoxin concentrations and household characteristics were evaluated for each fraction. Results: Outdoor endotoxin concentrations in both PM<sub>2.5</sub> and PM<sub>10-2.5</sub> were highest in autumn and lowest in winter. Indoor endotoxin concentrations in PM<sub>2.5</sub> were significantly higher in homes with carpet flooring and lower in homes that used air purifiers. Indoor endotoxin concentrations in PM<sub>10-2.5</sub> were higher in wooden houses than in houses of reinforced concrete. In both PM<sub>2.5</sub> and PM<sub>10-2.5</sub>, indoor endotoxin concentrations were higher than outdoor concentrations. In multivariate analyses, the indoor endotoxin concentrations in PM<sub>2.5</sub> and PM<sub>10-2.5</sub> significantly correlated with outdoor concentrations in each fraction (both  $p < 0.001$ ) and endotoxin levels in dust samples collected from mattress ( $p = 0.001$  and  $p < 0.001$ , respectively). Indoor endotoxin concentrations in PM<sub>2.5</sub> were also correlated positively with temperature, but no relationship between those in PM<sub>10-2.5</sub> and temperature was observed. Conclusions: These results showed that the indoor endotoxin concentrations were associated with the household characteristics including dust endotoxin in addition to outdoor endotoxin concentrations.

### **P03.1900. Using BenMAP for Assessing Health Impacts of Ozone Exposure: A Case Study in San Antonio**

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**Abstract:** The Environmental Benefits Mapping and Analysis Program (BenMAP) is used by the US Environmental Protection Agency (EPA) in regulatory impact and risk assessments. We used BenMAP to estimate the health impacts of changes in outdoor ozone to San Antonio, Texas residents. The 2017 ozone levels in the San Antonio area exceeded the 70 ppb National Ambient Air Quality Standard (NAAQS) for ozone. We estimated health impacts of changes in ozone levels from the 2010-2014 average (the baseline scenario) to a higher ozone scenario and a lower ozone scenario. Health outcomes included all-cause mortality, respiratory mortality, hospital admissions for respiratory and cardiovascular disease, emergency room visits for asthma, and school days lost. Respiratory mortality from long-term ozone exposures was the only health outcome for which statistically significant changes were estimated to occur due to changes in ozone levels. BenMAP estimated 19 (range of 13 to 25) respiratory deaths (2% of all annual respiratory deaths) would result from annual ozone increases from the 2010-2014 baseline to ozone levels in the higher ozone scenario (i.e., 2012 San Antonio ozone levels that exceed the current 70 ppb ozone NAAQS). Similarly, we estimated 24 (range of 17 to 32) deaths would be avoided as a result of ozone decreases from baseline to the lower ozone scenario that is lower than the NAAQS. The BenMAP results suggest a reduction in long-term respiratory mortality if ozone levels in San Antonio were reduced to a level that complies with the 70 ppb NAAQS and an increase in mortality from nonattainment. Study findings should be interpreted with caution because the biological mechanism for the effect of long-term ozone exposure on human health is not well understood. BenMAP relies only on evidence from epidemiological studies and these studies preclude a definite determination of causality due to their inherent limitations.

### **P03.1910. Short-Term Effects of Ultrafine Particles on Daily Mortality in Seven Spanish Cities**

Aurelio Tobias

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**Abstract:** Background Epidemiological evidence on the short-term effects of ultrafine particles (UFP), with aerodynamic diameter <100 nm, on human health is still unclear. We investigated the relationship between UFP and daily mortality in seven Spanish cities, with urban environments affected by different sources of air pollution, where standardized measures are routinely collected. **Methods** We collected daily data non-accidental and cardiorespiratory mortality and UFP counts from urban and sub-urban background monitors, for (from North-to-South) A Coruña, Barcelona, Madrid, Huelva, Seville, Granada and Tenerife. Each city contributed with at least two cumulated years of data between 2008 and 2014. We applied city-specific quasi-Poisson regression models adjusted for trend, seasonality, temperature, weekdays and public holidays and pooled them with random-effects meta-analysis. **Results** Average UFP daily levels ranged from 3,361 particles/cm<sup>3</sup> in A Coruña to 18,192 in Huelva particles/cm<sup>3</sup>. We found a week effect at lag 1 for non-accidental mortality, increasing homogeneously the risk 1.06% (95% CI=[-0.05 to 2.18%], I<sup>2</sup>=0%) for a rise of 10,000 particles/cm<sup>3</sup>. Similar results were found for cardiovascular mortality, increasing the risk 2.05% (95% CI=[-0.03 to 4.13%], I<sup>2</sup>=1.5%). We did not find an association between UFP and respiratory mortality. **Conclusions** We found weak evidence of an association between daily ultrafine particles and mortality. As UFP are mainly generated by traffic in urban areas, our findings suggest an improvement of traffic emissions. However, more toxicological studies are required to determine the pattern and origin of UFP. **Acknowledgements** This study was supported by the National Plan for I+D+I (project PI15/00515) co-funded by the ISCIII Directorate General for Evaluation and the European Regional Development Fund (FEDER).

**P03.1920. Air Pollution and Pulse Wave Velocity in Young and Middle-Aged Asymptomatic Adults: The Kangbuk Samsung Health Study**

Zhenyu Zhang

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**Abstract:** Objective: Long-term exposure to fine particulate matter less than 2.5 µm in diameter (PM<sub>2.5</sub>) and less than 10 µm in diameter (PM<sub>10</sub>) are associated with cardiovascular risk. The mechanisms underlying these associations remains uncertain. We evaluated the association between long-term exposure to particulate matter and brachial-ankle pulse wave velocity (PWV), a marker of arterial stiffness, in a large sample of asymptomatic men and women. Methods: Cross-sectional analysis of 102,316 participants in the Kangbuk Samsung Health Study (KSHS) who underwent a comprehensive health screening examination in Seoul or Suwon, South Korea, between 2011 and 2016. We used participant-specific spatiotemporal pollution concentration models, incorporating agency monitoring data and geographical predictors, to estimate PM<sub>10</sub> and PM<sub>2.5</sub> concentrations between 2008 and 2016. We measured PWV using an oscillometric method with cuffs placed on both arms and ankles. Results: The monthly average particulate matter concentrations over 2011-2016 ranged from 22.6-113.2 and 4.8-57.9 µg/m<sup>3</sup> for PM<sub>10</sub> and PM<sub>2.5</sub>, respectively. The average PWV was 1307.2 cm/sec. In fully adjusted models, a 10 µg/m<sup>3</sup> increase in 12-, 36-, and 60-month PM<sub>10</sub> exposure was associated with a PWV increase of 4.11 (95% CI 0.75, 7.48), 6.19 (2.86, 9.53), and 4.87 (1.47, 8.26) cm/s, respectively. The corresponding increases in PWV associated with a 10 µg/m<sup>3</sup> increase in 12- and 36-month PM<sub>2.5</sub> exposure were 6.31 (1.61, 11.00) and 3.14 (-2.49, 8.76) cm/s, respectively. The association of particulate matter with PWV was evident in men and women, but it was significantly stronger in men compared to women. Conclusions: Increased concentrations of particulate matter were independently associated with brachial-ankle PWV in a large sample of young and middle-aged asymptomatic adults. Our findings add to the increasing body of evidence that identifies arterial stiffness as a mediator of the cardiovascular effects of air pollution.

**P03.1930. Exposure to Fine Particulate Matter of Vehicular Origin Is Associated with Increases in Blood Pressure among Hypertensive Outdoor Workers**

Carmen Diva de André

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**Abstract:** Hypertension and air pollution are two important risk factors for cardiovascular morbidity and mortality. Although several studies suggest that air pollution has a significant impact on blood pressure, studies on long-term effects are sparse and controversial. **Aims:** To evaluate the effects of exposure to different levels of traffic-generated PM<sub>2.5</sub> on blood pressure in outdoor workers. **Methods:** 88 non-smoking workers, exposed to different concentrations of vehicular pollution, were evaluated weekly in four successive weeks. At each evaluation, they underwent personal monitoring of 24-hour PM<sub>2.5</sub> concentration and 24-hour ambulatory blood pressure. The association between the blood pressure variables and PM<sub>2.5</sub>, adjusted for age, body mass index, time in job, daily work hours, diabetes or hypertension and cholesterol was assessed by means of multiple linear regression fitted by least squares. **Results:** Exposure to PM<sub>2.5</sub> (ranging from 8.5 to 89.7 µg/m<sup>3</sup>) was significant and consistently associated with an increase of blood pressure. An elevation of 10 µg/m<sup>3</sup> in the PM<sub>2.5</sub> concentration was associated with increments of 4.2 (CI 95%= [2.8; 5.6]) and 2.8 mmHg (CI 95%= [1.6, 4.0]) in average systolic and diastolic 24-hour blood pressure, respectively. **Conclusion:** Exposure to fine particles, predominantly from vehicular traffic, was associated with elevated blood pressure in hypertensive workers. Less relevant effects were observed in non-hypertensive workers.

### **P03.1940. Personal Exposure to PM2.5 and Its Bioreactivity in Healthy Adults of Hong Kong**

Kin-Fai Ho

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**Abstract:** Background: Mechanisms involving systemic inflammation have been proposed to explain the associations between PM2.5 with cardiopulmonary morbidity and mortality. Experimental evidence suggests that organic constituents in PM2.5 have critical health impact. However, there are limited studies related to the bioreactivity of personal PM2.5 in vitro with toxic components.

**Methods:** Personal monitoring from 58 (aged 18-42 years) healthy adults during the summer and winter were conducted in Hong Kong. Personal exposures to PM2.5 as well as its chemical components including organic carbon, elemental carbon, polycyclic aromatic hydrocarbons (PAHs), and phthalates in personal samples were determined. Additionally, the bioreactivity of personal PM2.5 in vitro were evaluated. Cell variability, 8-isoprostane, lactate dehydrogenase (LDH), and interleukin-6 (IL-6) released were used to determine the PM bioreactivity. Using the mixed-effects model, the relationships of bioreactivity to personal exposure to PM2.5 components were examined.

**Results:** Winter exposures were 1.6-2.0 times greater than summer exposures for personal PM2.5, EC, PAHs, and phthalate. Personal exposure to OC was significantly correlated with LDH ( $p < 0.05$ ) and IL-6 ( $p < 0.01$ ). Moderate correlations ( $r_s = 0.58$ ,  $p < 0.05$ ) were observed between OC and EC, but no correlations were observed between EC with bioreactivity of PM2.5. **Conclusion:** In vitro methods have an important role in the screening of bioreactivity of PM2.5. Results suggest exposure to PM2.5 components can induce cytotoxicity and system inflammation in healthy adults.

### **P03.1950. Exposure to Ambient Air Pollutants, Polycyclic Aromatic Hydrocarbons and Female Infertility**

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**Abstract:** Background: Environmental exposures can result in adverse effects on female reproduction. This study aimed to evaluate the correlation between ambient particulate matter exposure, especially polycyclic aromatic hydrocarbons (PAHs), and female infertility. Methods: Data came from a cohort case-control study of female fertility in rural China. Cases were women who were not pregnant after 1 years of unprotected sexual life among newly married couples, while the controls were women who became pregnant during the first year of marriage. Blood samples, 48 hours indoor and outdoor air exposure samples were collected. GC/MS was used to detect 16 US EPA-priority PAHs in blood and air sample. Results: Total 12 pairs cases and controls were analyzed in the current study. The mean age of the subjects was (23.7±2.8) years, most of them finished senior high school education, resided in the current place for (4.2±3.2) years. Recovery rate of 15 PAHs was (95.4±4.8)% with the range of (85.9-110)%. Total weight of PM in case group was significantly higher than control group, which was (0.011±0.011) mg and (0.007±0.002) mg respectively (P=0.014). The weight of coarse particulate matter(CP, 2.1-10µm), fine particulate matter(FP, <2.1µm) and ultrafine particulate matter(UFP, <0.43µm) and PM<sub>2.5</sub> was significantly higher in cases. The concentration of PM in case group was significantly higher than control group, which was (0.126±0.122) µg/m<sup>3</sup> and (0.091±0.037) µg/m<sup>3</sup> respectively (P=0.008), so did with every type of PM (CP, FP, UFP) and PM<sub>2.5</sub>. The concentration of L\_PAHs was (4.589± 4.954) µg/m<sup>3</sup> and (9.289±10.283) µg/m<sup>3</sup> in case and control group respectively (P=0.009), and the concentration of H\_PAHs was (6.566±5.774) µg/m<sup>3</sup> and (5.316±7.133) µg/m<sup>3</sup> (P=0.359). Blood concentration of ANY, FLU, FLO, PYR and BghiP were higher in cases than controls. Conclusions: Our findings suggest that women exposed to PAHs may be at increased risk of infertility. Confirmation by further research is needed.

### **P03.1960. Carbon Monoxide Poisoning in Ontario, Canada: Identifying Causes and at Risk Populations**

Elaina MacIntyre

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Abstract: Carbon monoxide (CO) poisoning results in a substantial public health burden, a burden that is entirely preventable. In Ontario, if emergency services identify CO during a 911 response they will notify the Technical Standards and Safety Authority (TSSA), who then conduct a detailed site investigation. Ten years of investigation data (2007-2016) was examined to identify predictors of CO incidents and characteristics of individuals exposed, to ultimately help inform prevention strategies. Detailed information on 2,780 unique CO incidents and 374 individuals who were exposed to CO was assessed. Examining CO incidents by month, a seasonal trend was evident, with a higher occurrence of incidents in cold months (November to February). Across all age categories, incidents where an individual was exposed to CO occurred primarily in homes (private and multi-unit dwellings) versus commercial, institutional and industrial settings. Incidents peaked between 8:00am and noon and virtually all CO incidents between midnight and 7:00am were in homes. The most common cause of a CO incident was improper installation, operation, or maintenance of equipment. There were a total of 15 fatal injuries, 140 serious injuries (poisoning), and 191 minor injuries (nausea/dizziness, aches/pains). 68% of the injuries impacted working age adults (20-59 years), and injuries peaked at 40-49 years (6 per 100,000 population). Nausea and dizziness were the most common symptoms reported. Half of the fatal injuries involved older adults (>60 years) at home. In order to inform successful prevention strategies around CO poisoning, routine surveillance of CO incidents is needed to understand how these events occur and to identify the population at risk. TSSA data provide unique information to inform prevention efforts, such as public education on the importance of regular maintenance of fuel-burning appliances.

### **P03.1970. Chemical and Physical Characterization of Tire Crumb Rubber Used in Synthetic Turf Fields to Improve Exposure Assessment**

Kent Thomas

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Abstract: Tire crumb rubber from recycled tires is widely used as infill material in the 12,000+ synthetic turf fields in the United States. Tire crumb rubber is a complex material, with many potential chemical substances, presenting challenges for assessing human exposures. As part of U.S. Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds, researchers collected tire crumb rubber samples from nine tire recycling plants and infill from 25 outdoor and 15 indoor synthetic turf fields across the U.S. Fields were recruited from all four U.S. census regions, and ranged in age from new installations to 12 years old. Multiple analytical methods were applied to measure a wide range of metals, VOCs, and SVOCs. Particle sizes were characterized using gravimetric and SEM methods. Microwave acid digestion of tire crumb rubber with ICP-MS analysis was used to measure 20 elements. Tire crumb rubber was solvent extracted for analysis of approximately 50 PAHs, phthalates, thiazoles, and other rubber chemicals by GC/MS/MS and LC/TOFMS methods. Dynamic emission chamber testing was performed for VOCs and SVOCs at 25° and 60°C. Suspect screening and non-targeted analysis approaches were applied to assess the larger range of VOCs and SVOCs that may be associated with the material. Bioaccessibility of metals from tire crumb rubber was measured using simulated saliva, sweat, and gastric fluids. The range and variability in chemical substances measured within and between recycling plants and synthetic turf fields was examined. Differences in measurements among indoor and outdoor fields and fields with different age and region characteristics were assessed. This presentation will focus on key results from the application of this array of analytical methods, with a goal of improving our understanding and knowledge for assessing synthetic field user exposures.

### **P03.1980. Incorporating Mobile Monitoring Data in Spatio-Temporal Air Pollution Modeling**

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**Abstract:** Air pollution measurements from mobile platforms could potentially increase the accuracy of pollutant exposure prediction models. However, it can be challenging to separate spatial and temporal variability when including mobile measurements in exposure prediction models. This study investigates whether using mobile monitoring data in a spatio-temporal air pollution model can improve the performance of an exposure model in predicting NO<sub>2</sub> and NO<sub>x</sub> concentrations compared to a model created using only routine monitoring data. Three model scenarios were tested using a unified spatiotemporal modeling approach for the Los Angeles region from 2005 - 2014: 1) a model using two-week averaged AQS and the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) fixed site data only, 2) a model using those AQS and MESA Air fixed site data plus two-week averaged mobile monitoring data, and 3) a model using AQS and MESA Air fixed site data plus two-week averaged passive sampler data (concurrent and collocated with mobile monitoring). Additional measurements from MESA Air home sites were used for model validation. Models with either mobile monitoring data or passive sampler data improved model performance in home site predictions for both NO<sub>x</sub> and NO<sub>2</sub> compared to models developed from routine measurements only. Models using passive sampler data performed better than models created using mobile monitoring data. Results indicate that additional spatial information from mobile monitoring data can improve the spatio-temporal model performance, but passive sampler measurements may be preferable if available.

### **P03.1990. Fine-Scale Estimation of Air Pollutant Concentrations in an Urban Area Using a CMAQ-LUR Model**

Jin-Hee Bang

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Abstract: Studies on fine-scale air pollution modeling can improve the accuracy of the pollutant exposure assessment for a population in a complex urban environment. In this study, we predicted PM10 and NO2 concentrations at 100-m resolution using the land use regression (LUR) model based on Community Multiscale Quality (CMAQ) model and compared the differences between the simulated pollutant concentrations from the CMAQ-LUR and CMAQ models in the Seoul metropolitan region that experienced a high-concentration episode in 2016. The ArcGIS tool was used for analysis of predictor variables (land use, road, and altitude) and multiple regression analysis was performed using SPSS for statistical analysis of the LUR model. The developed CMAQ-LUR model simulated the high-resolution distributions of the daily mean PM10 and NO2 concentrations, showing higher concentrations at the intensive traffic network (highway and main road) and the industrial area; this result could be reasonably reproduced given the observational daily variations at several sites. When compared with the 1-km resolution CMAQ modeling results, the CMAQ-LUR model more clearly showed the heterogeneity of air pollution in an urban environment. Our study suggested that the CMAQ-LUR modeling approach can give reliable data for improving air pollutant exposure assessment of an urban population. Acknowledge :This work was supported by Korea Environment Industry & Technology Institute(KEITI) through the Environmental Health Action Program, funded by Korea Ministry of Environment(MOE)(2017001350003)

### **P03.2000. Global Mortality from Outdoor Fine Particle Pollution Generated by Fossil Fuel Combustion**

Alina Vodonos Zilberg

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**Abstract:** Background-The burning of fossil fuels, especially coal and diesel, is a major source of airborne fine particulate matter (PM<sub>2.5</sub>), and air quality has been implicated as key contributor to the global burden of mortality and disease. We aimed to undertake a global assessment of mortality associated with air pollution from fossil fuel combustion among adult population. We also estimated mortality due to lower respiratory infections (LRI) among children under the age of five in North America, South America and Europe. Methods-Global PM<sub>2.5</sub> exposure levels were derived from the chemical transport model GEOS-Chem. Relative risks and attributable fractions of mortality were modeled using function from meta-analysis of association between long-term exposure to air pollutants and mortality. Results-We estimate a total global annual premature mortality attributable to the fossil-fuel component of PM<sub>2.5</sub> with 6,69 million deaths. Greatest mortality is simulated over regions with substantial higher change in the PM<sub>2.5</sub> concentration, notably parts of eastern North America, Europe, and Asia. We also estimated the excess annual deaths due to child LRI with 794 in North America, 619 in South America and 523 in Europe. Conclusion-This study demonstrates that the fossil fuel component of PM<sub>2.5</sub> does have an important mortality burden. By quantifying the health consequences of fossil fuel combustion, a clear message is sent to policymakers and stakeholders of the co-benefits of alternative energy sources.

**P03.2010. Air Health Trend Indicator: Association between Short-Term Exposure to Ground Ozone and Circulatory Hospitalizations in Canada for 17 Years, 1996-2012**

Hwashin Shin

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**Abstract:** Background: The Air Health Trend Indicator is part of the Canadian Environmental Sustainability Indicators program in Canada. It is designed to estimate public health risk related to short-term exposure to air pollution and to detect trends in the annual national health risks. Design: Daily ozone, hospitalization (three circulatory diseases) and weather data for 24 urban cities (about 54% of Canadians) over a period of 17 years (1996-2012) were used. Through a Bayesian hierarchical model an estimator using 7-year blocks was employed to find trends in annual national associations by season, lag of effect, sex and two age groups ( $\leq 65$  vs  $> 65$ ). Results: The Canadian population is growing and aging but getting healthier as hospitalization rates have declined from 10% to 8%. Females were hospitalized more than males (57% vs 43%) and circulatory hospitalization was about 16% of all causes. This study examined three circulatory causes: Ischaemic heart disease (IHD, ICD\_I20-I25, 40% of cases), other heart disease (OHD, ICD\_I30-I52, 31%) and cerebrovascular disease (CEV, ICD\_I60-I69, 14%). For warm season the baseline national risk per 10 ppb of 1-day lagged ozone was 0.4% (-0.3%~1.1%) for IHD, 0.7% (0.05%~1.3%) for OHD, and 0.2% (-0.8%~1.2%) for CEV. While an age effect was identified, more difference was detected by sex, with males more vulnerable to ozone for CEV and OHD. While IHD showed decreasing trends for recent years (2009 onwards) regardless age and sex, CEV did slightly increasing trends overall. In contrast, CEV did mixed trends by sex, with an increasing trend for males only. Discussions: The sex-specific differences in circulatory hospitalization risk need further investigations. The study findings could reduce knowledge gap by identifying sub-populations susceptible to ozone by season, age, sex and trend. The temporal trends in ozone's impact on circulatory hospitalization could help develop air pollution regulations.

### **P03.2020. A New Approach for Inferring Traffic-Related Air Pollution: Use of Radar-Calibrated Crowd-Sourced Traffic Data**

Markus Hilpert

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Abstract: Crowd-sourced traffic data potentially allow prediction of traffic-related air pollution at high temporal resolution. Our goals were to examine associations between (1) radar-based measurements of traffic and congestion colors displayed on Google Traffic (GT) maps and (2) black carbon (BC) levels and radar/GT data. At an off-ramp of an interstate and a small one-way street in a mixed-use area in New York City, we used radar devices to obtain vehicle speeds and flows (hourly counts) for cars and trucks. We downloaded in real time GT maps and assigned an ordinal variable GCC to the Google congestion colors (GCC increased with vehicle speed). BC levels were monitored with aethalometers. Flow was highest for intermediate speeds and GCC. Relationships between GCC, vehicle speed and flow were different for the two road types indicating local calibration of GT data is needed. Regression analyses showed that BC levels increase with vehicle flow. At the off-ramp, BC depended additionally on vehicle speed, which was negatively associated with BC levels. Time-dependent BC levels can be inferred from time-dependent GCC data and average vehicle flow (radar-derived in our case). Use of inexpensive crowd-sourced traffic data holds great promise for use in air pollution modeling.

**P03.2030. 3Z: STEPWISE: Tackling Urban Air Pollution in a Low Resource Setting: A Qualitative Study**

Nika Lazic

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Abstract: INTRODUCTION: Air pollution is a global rising problem and its ill effects on human health are well established. For the first time air pollution can be found among 10 greatest risks for premature death globally. 92% of the worlds population is living in an area where the air quality does not meet the pollutant levels recommended by the "WHO air quality guidelines". Croatia, especially the city of Zagreb is facing a rising traffic problem without a defined strategy on dealing with it and reducing its effects on human health. Stochastic action as a result of specialised scientific staff and knowledge base deficit has provided suboptimal performance. AIM: To create a framework for appropriate air pollution reduction intervention in urban environment using a combined qualitative approach. METHODS: A modified nominal group of epidemiology residents in Croatia will be used to pinpoint the main issues underlying the low efficacy of existing traffic air pollution reduction strategies. Using the results of nominal group, a ranking list of the main issues will be made, identifying the potential targets for air pollution reduction intervention. Systematic review of literature (SRL) will be conducted, using the PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions, to identify existing traffic air pollution reduction interventions in urban environments. RAND-UCLA appropriateness method, using inputs from the nominal group and SRL will be used to select the most appropriate intervention for the local setting. Policy recommendation will be made to facilitate implementation of selected intervention. CONCLUSION: This project will emphasise air pollution as a greatest environmental risk for its citizens with concluding policy recommendation for air pollution reduction and individual action plan.

**P03.2040. Ambient Air Pollution and Cardiopulmonary Morbidity Outcomes in Columbia, South Carolina, 1999 to 2015**

John Pearce

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**Abstract:** Background: Much is still to be learned about the health effects of multiple air pollutants. Methods: We estimate acute health effects for single and multiple pollutants on multiple cardiopulmonary-related morbidity outcomes using time-series Poisson regression in Columbia, South Carolina between 1999 and 2015. Health outcomes included emergency department (ED) visits for asthma and upper respiratory infection (URI) and hospital admissions (HA) for congestive heart failure (CHF) and ischemic heart disease (IHD). Pollutants included daily measures of 1-hr max nitrogen dioxide (NO<sub>2</sub>) in ppb, 1-hr max sulfur dioxide (SO<sub>2</sub>) in ppb, 8-hr max ozone (O<sub>3</sub>) in ppb, and 24-hr particulate matter  $\leq$  2.5 microns (PM<sub>2.5</sub>) in  $\mu\text{g}/\text{m}^3$ . Multipollutant exposures were characterized using exposure categories defined by self-organizing maps based multipollutant day types (MDTs). Results: Single pollutant models found positive associations for 10-unit increases in PM<sub>2.5</sub> (asthma, IHD), O<sub>3</sub> (asthma, URI, CHF), SO<sub>2</sub> (asthma), and NO<sub>2</sub> (CHF, IHD), with the highest effects for asthma (RR: 1.014; 95%CI: 1.005-1.024). Multipollutant models found that, when compared to 'clean' air days, there were associations between the occurrence of four different MDTs exhibiting increasing pollution and increasing risk for two outcomes - asthma and IHD. The joint effects largest in magnitude were between asthma ED visits and days (MDT [2, 2]) experiencing elevated levels for all pollutants (RR: 1.023; 95%CI: 1.005-1.041). Conclusion: Using our framework, we found significant joint effects between multipollutant day types and cardiopulmonary morbidity.

**P03.2050. Impacts of Acute Changes in Air Pollution on Discharges from Implantable Cardioverter Defibrillators in Ontario, Canada**

Robin Shutt

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**Abstract:** Background: Acute changes in pollution have been associated with cardiac morbidity and mortality. Air pollution might impact cardiac morbidity and mortality through precipitation of cardiac arrhythmia in susceptible individuals. Despite gradual improvement in air quality over the past decades in North America, the links between days of higher pollution and cardiovascular morbidity and mortality still exist. This suggests that further research, at lower levels of ambient air pollution is warranted. The objective of this study is to examine the influence of acute changes in air pollution in Ontario, Canada on the frequency of discharges from implantable cardioverter defibrillators (ICDs) in response to cardiac arrhythmias. Methods: Using a case-crossover design, we compared ambient air pollution concentrations on the day of an ICD discharge to other days in the same month and year in 10320 patients with ICDs. We adjusted for weather, lagged the data from 0 to 3 days, and stratified the results by several patient-related characteristics. Results: Median (interquartile range) for SO<sub>2</sub>, NO<sub>2</sub>, ozone and PM<sub>2.5</sub>, were 1.0 ppb (0.4, 2.1), 10.0 ppb (6.0, 15.3), 26.0 ppb (19.4, 33.0) and 6.6 µg/m<sup>3</sup> (4.3,10.6) respectively. Odds ratios (95%CI) for an ICD discharge associated with an IQR increase in pollutant were 1.0 (0.91, 1.0) for SO<sub>2</sub>, 1.0 (0.9, 1.1) for NO<sub>2</sub>, 1.0 (0.9,1.1) for ozone, and 1.0 (0.9, 1.1) for PM<sub>2.5</sub>. Conclusion: Small day to day changes in air pollution at the relatively low levels seen in our study did not appear to be a risk factor for cardiac arrhythmias in patients with ICDs.

### P03. Global Health, Environmental Health Disparities and Other Social Issues 3

#### **P03.2070. Exposures to Volatile Organic Compounds (VOCs) among Rural and Urban Households in Southern India in Relation to Primary Cooking Fuels**

Naveen Puttaswamy

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**Abstract:** Background: Emissions from cooking fuels that include many health damaging pollutants such as fine particulate matter and a range of polycyclic aromatic hydrocarbons and volatile organic compounds (VOCs) are a major public health concern in low and middle income countries (LMICs). Despite the ubiquity of exposures in India, VOC profiles in rural and urban households are poorly understood. Methods: We report results from cooking period measurements conducted in 112 (56 biomass, 23 kerosene and 34 gas using ) rural and urban households that were part of the larger Tamil Nadu Air Pollution and Health Effects (TAPHE) cohort study in Southern India. Samples were collected on a mixed-bed sorbent (Tenax and Carbopack) tubes. Active air sampling was performed using pre-calibrated constant flow pumps (SKC Inc., PA, USA) set to a flow rate of 0.1 L/min for 100 min. An automated thermal desorption unit connected to GC-MS system was used to quantify 59 VOCs. Pentafluorobenzene, 1,4-difluorobenzene and chlorobenzene-d5 were used as internal standards and percent recovery ranged from 81.7% to 119.9%. Results: Total VOC (TVOC) concentrations in rural homes (4426.8 µg/m<sup>3</sup>) were significantly higher when compared to urban homes (2010.9 µg/m<sup>3</sup>). Toluene, styrene, m,p-xylene and benzene were dominant in rural kitchens whereas toluene, m,p-xylene, benzene and isopropyltoluene were dominant in urban kitchens during cooking. Mean TVOC concentrations were the highest in biomass using homes (4617 µg/m<sup>3</sup>) followed by LPG (2839.7 µg/m<sup>3</sup>) and kerosene (1639.8 µg/m<sup>3</sup>) respectively. Benzene levels consistently exceeded the National Ambient Air Quality Guideline value of 5µg/m<sup>3</sup> in all rural and urban homes. Winter season, open field burning and industry nearby were associated with significantly higher VOC concentrations. Conclusions: Additional large scale assessments of population exposure to VOCs are needed in LMICs to better characterize health risks associated with solid fuel use.

### **P03.2080. Addressing Health and Environmental Impacts of Reliance on Solid Fuel and Kerosene for Cooking in Cameroon: Strengths and Challenges of the National LPG Masterplan**

Rachel Anderson de Cuevas

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**Abstract:** Background: Cameroon relies on biomass fuel (mainly wood) for cooking, (88% rural population), with important health, deforestation and climatic consequences. The Government aims to increase Liquefied Petroleum Gas (LPG) use from < 20% to 58% of the population by 2035 and developed a Masterplan (2016) to achieve this goal via a multi-sectoral committee (ministries, national agencies, private sector and the Global LPG Partnership). An Investment Committee was established to oversee implementation. Objectives: To document and evaluate the Cameroon national process for LPG scale-up. Methods: The RE-AIM framework structured data collection and reporting: secondary data (socio-economic development, energy situation, policy); Masterplan documentation; LPG market expert and national stakeholder interviews; and LPG Adoption in Cameroon Evaluation (LACE) study data (community data on fuel use, stacking, barriers to LPG use, microloan schemes, impacts on particulate air pollution (PM2.5) and health). A logic model compared Masterplan proposals with issues reported by users and stakeholders. Findings: Masterplan recommended: €400 million investment to 2030 to increase LPG cylinders by 7 million, infrastructure developments (storage, transport, distribution and retail facilities), enhanced market regulation, national harmonisation of refill price and cylinder import tax reductions. The LACE studies highlighted user concerns about costs, safety, access, supply and cooking traditional foods. Stakeholders proposed increasing microfinance initiatives, LPG promotion, user support and health system engagement to promote clean fuels. Conclusions: The Masterplan has the potential to address problems of LPG access and supply and improve industry safety. Microfinance is supported and new pricing arrangements may lower cylinder deposit costs. Users' concerns (affordability, access, safety, traditional cooking) need consideration. Programme monitoring and evaluation is recommended.

### **P03.2090. Air Pollution and Childhood Respiratory Health in Nigeria**

Adetoun Mustapha

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Abstract: Nigeria is projected to become the world's third most populous country by 2050. It has an oil-based economy and is a major emitter of green house gases from gas flaring. It is close to the Sahara desert, a major contributor to global dust. Nigeria has the third highest infant mortality rate in the world with about 20% caused by respiratory tracts infections. Epidemiologic studies have demonstrated decline of air pollution levels and improved respiratory health in children in developed countries. A literature search was conducted on Google Scholar to explore the extent to which cumulative exposure contributes to childhood respiratory health in Nigeria. The search was carried out on 28 March 2018 and limited to articles that were published in English Language since 2008. Additionally, the reference lists of relevant articles were manually checked. One hundred and twenty-five (125) full papers were assessed and 10 studies that measure exposure and respiratory health outcomes in children reviewed. The studies were mainly cross-sectional with varied exposure assessment methods. Reliable health data was lacking, recall method was used to collect information. Ambient or indoor air monitoring for PM, CO, SO<sub>2</sub>, NO<sub>2</sub> was done with portable monitors over a short period. In our earlier reported survey of 1397 children aged 7-14 years from low socio-economic schools in Warri (Mustapha et al, 2011), almost all the children (99.3%; 95% CI 98.8-99.7%) reported some form of school or home pollution from traffic fumes or open bush burning or cooking smoke (non-industrial) and gas flaring (industrial) at school or home. About two-third agreed that breathing clean air in various microenvironments prevents respiratory illness. Global health improvements require more interests in impact of air pollution on Nigerian population health. Further research is needed on how personal exposure related to the varied microenvironments contributes to the respiratory health of children in this region.

## **P03.2100. Clean Household Energy for Cooking in Low- and Middle- Income Settings: An Interdisciplinary Case Study Project to Advance Knowledge Translation**

Ashlinn Quinn

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**Abstract:** Approximately 3 billion people rely on solid fuels and kerosene for their cooking needs. Exposure to household air pollution from burning these fuels accounts for approximately 3 million premature deaths a year. Clean fuels - such as liquefied petroleum gas (LPG), ethanol, biogas, electricity, and certain compressed biomass fuels - have the potential to alleviate much of this health burden, but to achieve health impact, uptake of the interventions must be widespread and sustained. Many clean fuel intervention programs are being implemented in low- and middle-income settings around the world, but few of these efforts have been evaluated. The Clean Cooking Implementation Science Network supported by the NIH and partners developed a set of eleven case studies, describing: LPG scale-up initiatives in Cameroon, Ghana, Indonesia, and Peru; biogas programs in Cambodia and East Africa; compressed biomass projects in Rwanda and China; alcohol fuel programs in Ethiopia and Nigeria; and a case in Ecuador covering LPG and electric induction cooking. We used RE-AIM (reach, effectiveness, adoption, implementation, maintenance) - an implementation science framework designed to organize and integrate information important in the translation of research to practice - to coordinate and evaluate the case studies. Results of this project include the eleven case studies themselves, a dataset that summarizes the programs using the RE-AIM framework, and a general conceptual model to support future planning and evaluation of household energy programs. Among the emergent results is the fact that traditional cooking practices tend to persist for multiple reasons (e.g. due to fuel supply interruptions, availability of free solid fuel, or cultural preferences) even when access and affordability are increased. Recommendations for such programs going forward are to include household-level monitoring of stove use patterns and to actively incentivize transition to near-exclusive clean fuel use.

**P03.2120. Urban and Rural Differences between Chemical and Social Environmental Risk Factors and Population Health, the Importance of Context**

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Abstract: Relationships between social disadvantage and environmental exposures are complex and vary by geographic context and outcomes. However, few population-based studies have data to test these differences. The overarching goal of this study was first to examine the associations between cumulative socio-environmental stress and ambient air pollution with lung function then with body mass index (BMI) and examine how relationships differ in urban and rural contexts. Using data from 2400 adult participants of the Survey of the Health of Wisconsin, an additive socio-environmental stress index (SESI) was created from self-reported estimates of six social and built environment factors including self reported stress, poor neighborhood aesthetics, maintenance, presence of garbage and litter, limited safety from crime and lifetime discrimination. Three-year chronic air pollution exposure was estimated using USEPA's Bayesian space-time downscaler model for PM<sub>2.5</sub>. Both BMI and lung function were objectively measured during an exam visit. After careful adjustments, results showed no association between the non-chemical SESI and lung function in the overall study population. In contrast, three-year chronic air pollution was associated with reduced lung function ( $p < .03$ ). In fully adjusted models of chronic air pollution and lung function that tested for potential mediation by SESI, associations were slightly attenuated but remained significant. In stratified analyses, air pollution was only associated with reduced lung function in urban populations. Repeating analyses with body mass index as the primary outcome found opposite associations. Exposure to SESI but not chronic air pollution was a predictor of increased BMI ( $p < .001$ ). Stratified analyses revealed associations persisted in rural but not urban areas. Results highlight the importance of context in teasing out complex relationships between chemical and social environmental factors impacts on population health.

### **P03.2130. Polycyclic Aromatic Hydrocarbons and Their Oxygenated Derivatives in a Typical Small City in Northwest China: A Pilot Study**

Sa Liu

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**Abstract:** Due to severe ambient air pollution, Chinese government has taken tremendous effort to reduce air pollution and achieved noticeable progress. However, control strategies have been focused on major cities and key areas, leaving rural area and small cities largely unaddressed. This study examines ambient air pollution in Lintao, Gansu Province (a typical small city in northern China), in comparison with that was in Lanzhou, the provincial capital and largest city in northwest China, and the potential immunological effects in children living in these two cities. We collected air pollution samples at a selected study site in each city from December 2015 to June 2016, for polycyclic aromatic hydrocarbons (PAHs), oxygenated-PAHs (OPAHs) and PM<sub>2.5</sub>. We also acquired publicly available data and analyzed remote sensing data to complement measurement data. In addition, we collected limited simultaneous samples at multiple locations in each city to evaluate the spatial variation of pollutants. PAH samples were analyzed for 16 US EPA priority PAHs and 17 OPAHs. Blood samples were collected from children (n=21 in each city) and analyzed for immune markers reflecting T-regulatory (Treg) cell function. We found that although average PM<sub>2.5</sub> concentration in Lintao was marginally lower than it was in Lanzhou (55 vs. 66  $\mu\text{g}/\text{m}^3$ ), PAH and OPAH concentrations (sum of 16 PAHs and 17 OPAHs, respectively) were actually much higher in Lintao than in Lanzhou (495 vs. 218  $\text{ng}/\text{m}^3$  and 139 vs. 102  $\text{ng}/\text{m}^3$ , respectively). Notably, we observed lower gene expressions for immune transcription factors and cytokines in children living in Lintao, suggesting impaired Treg cell function potentially related to PAH/OPAH exposure in Lintao. We hypothesized that the use of coal and biomass in Lintao was the major reason for the high PAH/OPAH pollution and the repressed Treg cell function, as coal and biomass use was not regulated in Lintao but was stringently restricted in Lanzhou.

### **P03.2140. Personal and Area Monitoring of Particulate Matter in an Informal Electronic Waste Recycling Site: A Preliminary Study**

Lawrencia Kwarteng

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**Abstract:** Background: E-waste recycling activities results in release of a mixture of pollutants, including Particulate Matter (PM) into the ambient environment. Exposure to PM could have deleterious health effects, mostly dependent on concentration and composition. A combination of area and personal monitoring is important in estimating both long and short term/acute exposures, important for health risk assessment. Objectives: The aim of this preliminary study is to assess exposure levels to PM among e-waste recyclers at Agbogbloshie, an informal e-waste recycling site through personal air monitoring and area monitoring. Methods: This study is part of the ongoing West Africa GEOHealth II study. Nine e-waste workers (five burners and 4 dismantlers) were selected in October for the study. Each participant undertook a one-time personal air monitoring for four hours by wearing a back pack containing a real time monitor, Met One Aerocet 831 which measured PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>4</sub>, PM<sub>10</sub>, and TSP every minute. Simultaneously, onsite area monitoring was also done. Pearson correlation was used to determine the relationship between PM measured in personal and area monitoring. Results: Overall, burners recorded higher mean PM concentrations, PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>4</sub>, PM<sub>10</sub>, and TSP (41.20±5.98, 74.89±15.54, 122.90±37.77, 215.86±106.6 and 293.15±160.93) compared to dismantlers (34.36±3.67, 54.81±7.13, 81.86±10.88, 128.35±26.33, and 169.64±42.40). There was a positive correlation between average personal and area PM and TSP values ( $r = 0.994$ ) Conclusion: Ewaste activities results in the release of high levels of PM and TSP which could have negative implications on respiratory health of ewaste workers.

### **P03.2160. Early Detection of Severe Dengue Infection in the Emergency Department: An Epidemiological Approach**

How-Ran Guo

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**Abstract: Objectives.** We develop an epidemiological approach to determine the emergency patients at high risk of severe dengue (SD), known as hemorrhagic fever (DHF) or dengue shock syndrome (DSS), and to facilitate timely appropriate medical treatment reducing the number of complications and death by the scoring system. **Methods.** This retrospective study was conducted during 2015 dengue outbreak in southern Taiwan. An efficient scoring system has been created to differentiate SD by clinical and laboratory features. Type A was defined as cases who were less than 65 years of age, and have none of the dengue related underlying diseases (DM, CKD or ESRD, liver cirrhosis, COPD, CHF, and neoplasm) according the WHO guidelines. Type B were those aged 65 years and older, and with any of the dengue-related underlying diseases. Significant coefficients of parameters were transformed into SD scores and constructed by division of each coefficient with the smallest coefficient of the multivariate logistic regression models by the backward stepwise selection. The accuracy and validity of SD scores are tested and predicted. **Results.** The severity scores ranged from 1 to 3, and the sum of total scores were 10. Significant parameters were used to construct possible SD models to distinguish a higher critical odds ratio when there was an underlying diseases [Adjusted OR, AOR (AOR: 22.68, 95% CI: 6.86-74.96)], tachypnea (AOR: 2.91, 95% CI: 1.29-6.56), shock (AOR: 15.52, 95% CI: 3.97-60.65-), and aPTT prolonged (AOR: 4.48, 95% CI: 2.05-9.78), and Hepatitis (AOR: 2.48, 95% CI: 1.07-5.74). An AUC of 0.82 was obtained which confirmed the good performance of the model. Positive likelihood ratio (LR+) of 10.74 indicates that the result greater than or equal to the severe score of 8 has a large effect on increasing the probability of SD presence. **Conclusions.** Our study has demonstrated an efficient scoring system to predict SD. The further validation of SD application should be confirmed.

**P03.2180. Factors and Developments Related to the Exposition (Direct and Indirect) of People to Mercury in Mines: A Systematic Review, 2005-2017**

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Abstract: Mercury is a chemical called heavy metal, which is used in mining activities especially that related to the extraction of gold by people who work in this trade, presented in them affectations in their health by having direct and indirect contact with this chemical. Objective: to identify risk factors for people associated with direct and indirect contact with mercury within the mining activity. Methods: systematic review following the statement PRISMA, is directed with the direct and indirect contact of mercury and its effects on health, was based on data such as Pubmed, Science Direct, Scielo, Cochrane and Lilac. Results: The main findings of the present review showed that most of the factors and outcomes related to exposure (direct and indirect) develop over time and are caused by work in mines or by the environment (surrounding population). Conclusions: The different authors agree that exposure to mercury directly or indirectly has harmful effects on human and environmental health, however, further studies should be conducted to take more significant measures to mitigate the effects of mercury on humans and the environment. Keywords: Mercury, mining workers, effects in the health, factors of risk. Keywords: Mercury, mining workers, effects in the health, factors of risk

**P03.2190. Health Risks Associated to Vulnerability of Water and Sanitation System in a West African Medium-Sized City: A Spatial Epidemiological Approach**

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**Abstract:** Background: African cities are facing critical societal challenges linked to environmental and health changes. These changes are induced by urbanization dynamics with limited urban development governance and basic services delivery. Using environmental, epidemiological and spatial indicators, this study aims to assess the impact of Mbour's social-ecological system on diarrhoeal diseases transmission with particular emphasis on vulnerability to environmental health risks according to water and sanitation status. Methods: A multidisciplinary survey was undertaken in 2016 in Mbour, Senegal, targeted 800 households. Statistical and spatial methods were used to address environmental health challenges and health risks distribution and inequalities in the city. Results: The findings from the household survey showed an insufficiency in clean water access, hygiene and sanitary systems in Mbour that foster diarrhoea transmission pathways. It showed that 58% of the surveyed household are connected to water networks with significant disparities between localities; and 72% of the household empty their wastewater in the street. Diarrhoea morbidity (33%) was higher in the neighbourhoods with the largest number of contaminated drinking water especially in the most densely populated neighbourhoods of the city. Mapping revealed that diarrhoea risk is spatially variable in accordance to environmental sanitation disparities. Conclusion: The dynamic of socio-ecological system demonstrated that environmental factors linked to unimproved drinking water sources and sanitation services were the main driver of diarrhoea transmission in the city. The linkage between health risks due to diarrhoea and environmental conditions addresses the issues of the Sustainable Development Goals (SDGs), especially the SDG 3 and 6 respectively on Health, Water and Sanitation. This calls for more research to contribute to more efficient urban health policies in Mbour context and in other cities across Africa.

**P03.2200. Impact on Health and Environment from the Viewpoint of the Families Affected by the Installation of the Foz Do Chapecó Hydroelectric Power Plant in the State of Santa Catarina, Brazil**

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**Abstract:** Objective To analyze the impact on health and environment from the perspective of families affected by the installation of the Foz do Chapecó Hydroelectric Power Plant in the state of Santa Catarina/Brazil. Method This was study conducted with 13 farming families affected by the reservoir of the power plant, whose data were collected through interviews. The analysis was based on the methodology of thematic analysis with the construction of categories. Results The analytical categories were: "Social and environmental changes experienced by families" and "The impacts on health resulting from the change of the environment". The effect on human health due to the environmental changes caused by the hydroelectric power plant may have physical or mental nature, which is reflected in feelings of insecurities that should be considered as a risk to trigger health problems and changes in the quality of life of this population. It was observed that the surveyed families were very linked to the place where they lived, and that the departure from their places of origin entailed cultural losses and social disruptions. They left strong feelings of distress and insecurity about the future. Some of them express the feeling of discomfort with the houses and working conditions found in the new place where they started to live. Regarding the environment, the surveyed families recognize that there has been a big change with alterations in flora and weather. They also highlighted that the change of the natural environment produced impacts on human health that are mainly manifested in the form of diseases such as depression, hypertension, insomnia and alcoholism. Conclusion the change of the environment with the installation of a hydroelectric power plant entailed social, economic, environmental and health impacts to the affected population. The different sectors involved in the licensing process should adopt new ways of assessing impacts at the time of implementation of this type of enterprise.

### **P03.2210. Shale Gas Activity and Increased Rates of Sexually Transmitted Infections in Ohio, 2000-2016**

Elise Elliott

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**Abstract:** Background: The shale gas ("fracking") industry depends on a mobile workforce, whose influx could have social impacts on host communities. Sexually transmitted infections (STIs) can increase through sexual mixing patterns associated with labor migration. No prior studies have quantified the relationship between shale gas activity and rates of three reportable STIs: chlamydia, gonorrhea, and syphilis. Methods: We conducted a longitudinal, ecologic study from 2000-2016 in Ohio, situated in a prolific shale gas region in the United States (US). Data on reported cases of chlamydia, gonorrhea, and syphilis by county and year were obtained from the Ohio Department of Health. All 88 counties were classified as none, low, and high shale gas activity in each year, using data from the Ohio Department of Natural Resources. Annual rate ratios (RR) and 95% confidence intervals (95% CIs) were calculated from mixed-effects Poisson regression models evaluating the relationship between shale gas activity and reported annual STI rates while adjusting for secular trends and potential confounders obtained from the US Census. Results: Compared to counties with no shale gas activity, counties with high activity had 21% (RR=1.21; 95%CI=1.08-1.36) increased rates of chlamydia and 19% (RR=1.19; 95%CI=0.98-1.44) increased rates of gonorrhea, respectively. No association was observed for syphilis. Conclusion: This first report of a link between shale gas activity and increased rates of both chlamydia and gonorrhea may inform local policies and community health efforts.

### **P03.2220. Drinking Water Salinity Categories and Lower Blood Pressure: Evidence from Coastal Bangladesh**

Matthew Gribble

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**Abstract:** Background: The goal of this study is to assess how electrical conductivity (EC), an aggregate measure of all minerals in water, is associated with blood pressure in southwest coastal Bangladesh. Method: This analysis included 1,574 persons from 708 households participating in drinking water salinity reduction studies in southwest coastal Bangladesh in 2016-2017. We used multilevel regression models to estimate differences in mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) across water salinity categories defined by the Food and Agricultural Organization of the United Nations: freshwater (electrical conductivity < 0.7 mS/cm), mild saline (EC ≥ 0.7 and < 2 mS/cm), and moderately saline (EC ≥ 2 and <10 mS/cm). EC was measured by Hanna Salinity™ meter. Models included participant-, household-, and community-level random intercepts and were adjusted for age, sex, body mass index, physical activity, smoking status, and household wealth. We also considered associations of EC with 24-hour urine biomarkers of Na, K, Ca and Mg intake using linear or parametric quantile regression models with the same adjustments and random effects. Missing data were handled by multiple imputations with chained equations. All results are reported with cluster-robust standard errors. Results: Drinkers of moderately saline water had 1.66 [95% confidence interval (CI): 0.13, 3.19] mm Hg lower mean SBP and 1.30 [95% CI: 0.46, 2.13] mm Hg lower mean DBP compared to freshwater drinkers in adjusted models. Drinkers of moderately saline water had 17.50 [95% CI: 12.54, 22.45] mmol/day higher mean urinary Na, 0.32 [95% CI: -1.59, 2.23] mmol/day higher mean K, 1.24 [95% CI: 1.08, 1.41] times higher median daily urinary Ca, and 1.27 [95% CI: 1.10, 1.47] times higher median daily Mg compared to drinkers of fresh water in adjusted models. Conclusion: Higher drinking water salinity was associated with lower blood pressure, perhaps due to higher levels of salubrious minerals.

**P03.2230. A Critical Analysis of a Community-Based-Participatory Study in Environmental Health: Methodology, Results and Perspectives for Local and National French Stake-Holders.**

Mélina Le Barbier

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**Abstract:** Community-based-participatory study in environmental health is relatively rare in Europe. Santé publique France (the French National Public Health agency) was commissioned by a local health authority to analyze the method implemented in a Franco-American participatory survey in industrial port zone of Marseille, and the subsequent results on the impact of industrial exposures on the population's health. To respond to this referral, Santé publique France set up an interdisciplinary support committee. The committee considered that the existence of risk excesses for several diseases reported in the study and their extent were limited by selection biases of the sample surveyed, the selected references, and the adjustment methods used. Despite methodological limits, the results presented confirmed that this territory requires a great level of attention from the public authorities. Committee also highlighted that the community-based epidemiological approach, based on people's perceptions and experience, seems to complement the approach of traditional epidemiology. As in many other industrial sites, community members of this zone have to deal with industrial and economical tool preservation and also sanitary effects of environmental pollution generated by these activities. In order to properly identify and manage the situation and to implement effective health risk prevention measures, it is necessary to take into account the entire territory, its stake-holders and its socio-economic history. We propose to expose and discuss results, conclusions and perspectives of this critical analysis. We will also expose methodology of this interdisciplinary critical analysis and how the community-based-participatory dynamic was considered by local stake-holders in a complex political and cultural context.

### **P03.2240. Potential Role of the Growth and Empowerment Measure to Enhance Environmental Health Research and Interventions**

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Abstract: The often-overlooked ability to protect and restore lost psychosocial wellbeing and mental health in the face of increasing environmental stress, dwindling capacity to meet basic needs and climate change is arguably one of our greatest health challenges. Poor mental health is already a leading contributor to the global burden of disability and reduces human capacity for collective planning and innovating, responding to crises and recovering from disasters and losses. Multiple environmental distresses, from water and food insecurity to climate change, place enormous pressure on people's ability to feel in control, see meaning and purposes in their lives and stay connected to one another in increasingly desperate circumstances. This situation is familiar to Aboriginal Australians, who have endured systematic disempowerment of their culture and families and dispossession of their Lands, waters and governance by Europeans since 1788. Although huge health inequalities remain between Aboriginal and non-Indigenous Australians, Aboriginal people have made remarkable contributions to Australian society and health research - especially towards understanding healing and empowerment. This presentation will argue the relevance of empowerment to address global and local environmental health challenges. We will introduce the Australian Aboriginal-informed tool, the Growth and Empowerment Measure [GEM], which measures complex psychosocial domains, e.g. identity, healing from painful feelings, creating safety, self-efficacy, voice, spirituality and community strength. Confirmatory Factor Analysis has demonstrated GEM's cross-cultural validity and measurement invariance (Indigenous and non-Indigenous). We will discuss its potential contribution to environmental epidemiology, eg identifying community empowerment needs, health impact assessment (especially of developments that threaten fundamental environmental values) and evaluation of environmental health interventions.

### **P03.2250. Exposures to Urban Wildlife and Ectoparasitic Insects among Homeless Persons in Boston, MA**

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Abstract: Urban homeless persons in the United States spend extended periods of time outdoors and may live in crowded conditions with poor hygiene. These settings may increase exposure to animal and insect vectors of disease, including wild rodents, feral cats, wild birds, lice, fleas, and ticks. Despite these risks, assessments of the frequency and risk factors for zoonotic and vector-borne infections among homeless people are limited. To address frequency of exposure to potential sources of zoonotic and vector-borne disease, we queried a cross-sectional sample of patients served by Boston Health Care for the Homeless Program's primary care facility (n=194) as to their sightings of urban wildlife and experiences with ectoparasitic insects. Nearly thirty percent of participants reported daily rodent sightings, and 25% reported daily sightings of cats. Body lice and fleas were reported by 4% and 11% of participants, respectively. Individuals who slept outdoors had more than 13 times the odds of greater frequency of rodent sightings in the last three months compared with those who did not sleep on the street (OR: 13.3; p=0.001; 95% CI: 2.7, 65.3). Heavy drinking was significantly associated with greater frequency of sightings of rodents (OR: 2.5 (1.0, 6.4); p=0.05), cats (4.5 (1.8, 11.5); p=0.002) and dead birds (3.3 (1.4, 7.9); p=0.007). Heavy drinking was also positively associated with ever-experiencing a parasite infestation during periods of homelessness (p=0.03). Frequent sightings of rodents and rodent feces by homeless people in particular may indicate human exposure risk to urban rodent-borne pathogens, including *Leptospira* spp, Seoul hantavirus, and *Rickettsia akari*. Exposure to cats suggests that *Bartonella henselae* infection in homeless persons is worthy of investigation. These infections may be underreported or misdiagnosed in this population. Studies of zoonotic and vector-borne infections among persons experiencing homelessness are warranted.

### **P03.2260. Urinary Chromium and Dyslipidemias: A Cohort Study of Urban Adults in China**

Lili Xiao

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**Abstract:** Abstract Background: Chromium is recognized as a nutritional enhancer and necessary for normal carbohydrate and lipid metabolism. However, the health effects of chromium exposure on lipoprotein metabolism have not been well evaluated. Objective: To investigate the cross-sectional and longitudinal effects of urinary chromium concentration on lipids levels or risk of dyslipidemias in a general Chinese population from the Wuhan-Zhuhai cohort study. Methods and Results: Serum lipids levels and urinary chromium concentration were measured at baseline and follow-up. Associations of urinary chromium concentration with lipids levels or risk of dyslipidemias were analyzed by generalized linear and binary logistic regression models, respectively. We found significant associations of increased urinary chromium concentration with reduced serum triglycerides (TG) level and elevated high-density lipoprotein cholesterol (HDL-C) level at baseline and follow-up. With adjustment for covariates, each one-unit increase in log-transformed urinary chromium concentration was associated with a 0.25 mmol/L decline in TG, and a 0.05 mmol/L ascend in HDL-C (all  $P < 0.05$ ). Downward trends of dyslipidemias (hyperTG and hypoHDL-C) were significantly associated with increasing quartiles of urinary chromium concentration (all  $P$  trend  $< 0.05$ ). Our results also suggested that urinary chromium levels were associated with coarse grain intake in both male and female participants. Conclusion: This study provides evidence that elevated urinary chromium concentration was associated with decreased risk of dyslipidemias in a general Chinese population. These findings warrant replication in other studies with adequate sample sizes.

### **P03.2270. Changes in Activities of Daily Living in Aging Congenital Minamata Disease Patients**

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Abstract: Severe methylmercury poisoning occurred in Minamata and neighboring communities in Japan during the 1950s and 1960s. A considerable number of children were born with conditions resembling cerebral palsy, later known as congenital Minamata disease. Although these children are now in their 50s or 60s, assessments measuring changes in activities of daily living (ADL) have not been performed as they age. We therefore assessed the changes in ADL status of surviving patients. We recruited a total of 11 congenital Minamata disease patients and obtained the patients' ADL status approximately 10 years previously from their caregivers or from hospital records. For comparison, we assessed the current values of the two ADL measures [Barthel Index (BI) and Functional Independence Measure (FIM)]. We compared the current and previous ADL status of the patients using Wilcoxon signed-rank test. Both ADL measures, including the status related with cognition, had significantly declined during the 10 years. The same was true for the BI score ( $p=0.01$ ). Similarly, all functions of the FIM scores declined (i.e., self-care, sphincter control, mobility, locomotion, communication, and social cognition), and for FIM physical and cognition subscores as well as FIM total score, the declines were statistically significant. The present study indicates that the ADL status of the congenital Minamata disease patients in their 50s or 60s declined significantly during a time interval of about 10 years, a decline that was fairly steep in comparison with expectation in subjects of similar ages. While already incapacitated due to the prenatal methylmercury poisoning, their accelerated ageing suggests that patients with developmental neurotoxicity have less reserve capacity to compensate for normal ageing. These patients need continuous and intense medical and welfare support in the community.

**P03.2290. Association between Urinary Metal Levels and Chronic Kidney Disease in Residents Living near to a Big Petrochemical Complex**

Tzu-Hsuen Yuan

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**Abstract:** Background/Aim Previous studies showed that exposure to heavy metals was associated with alteration of kidney function, and burning fossil fuels and petrochemicals may release metal pollutants. We conduct a study to investigate whether the kidney functions are decreased for residents living in the vicinity of a petrochemical complex. Methods We recruited 1,374 aged above 35 years in 2014-2016 who lived in Dacheng township, which is near the largest complex in central Taiwan. The subjects were classified into adult and elderly by a cut-off age 65 years. Two Chronic kidney disease (CKD) indicators were as potential outcomes of exposure: (1) eGFR calculated through the equations of Chronic Kidney Disease Epidemiology Collaboration; (2) CKD defined as eGFR lower than 60 ml/min/1.73m<sup>2</sup>. We conduct linear and logistic regression to investigate the association between the exposure and CKD. The regression models were adjusted for adjusted for gender, body mass index, smoking habits, and diabetes. Results Our 1,374 study population were classified into 689 adults and 685 elderly with mean age of 51.1 years and 73.3 year, respectively. Among the 689 adults, 11%, 9% had diabetes, CKD; and the mean eGFR was 70.8 ml/min/1.73m<sup>2</sup>. Among the 685 elderly, 17%, 38% had diabetes, CKD; and the mean eGFR was 62.7 ml/min/1.73m<sup>2</sup>. Urinary nickel, vanadium, chromium, arsenic and cadmium levels increased as the distance to the petrochemical complex decrease. A decreased eGFR was associated with urinary nickel, vanadium, chromium and distance to Complex in adults and elderly; and urinary arsenic and cadmium only in adult. An increased CKD was associated with distance to Complex in adults and elderly; and urinary nickel, vanadium and chromium only in elderly. Conclusions We concluded that exposure to heavy metals were associated with decreased renal function and increased risks of CKD in the adults or the elderly living in the vicinity of a petrochemical complex.

### **P03.2300. The Correlation between Pesticide Exposure and Health Effects among Tobacco Farmers, Northern, Thailand**

Saowanee Norkaew

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Abstract: Tobacco farm is one of the crops using load of pesticides, especially Organophosphates pesticides. Enzymes cholinesterase has been used to monitor the extent of organophosphate and carbamates exposure in tobacco farmers. The objective of this cross-sectional descriptive study was to investigate the correlation between pesticide exposure and health effects among tobacco farmers, Northern, Thailand. A questionnaire and blood enzymes erythrocyte cholinesterase test was completed by face to face from 44 tobacco farmers in 2016-2017. Data were analyzed using descriptive statistics and Chi-Square test and Fisher's exact test. The results showed that the most of the participants were female (75.0%), age between 51-60 years (54.5%) and educational levels in primary school (79.5%). It was found that the prevalence of unsafe level of enzymes cholinesterase was 90.9%. Most tobacco farmers mentioned their health symptoms were excessive sweating (47.7%), irritation of the throat and restlessness (34.1%). Some of them reported the running nose and muscle cramp (29.5%). Association between health symptoms and blood enzymes erythrocyte cholinesterase test was shown that; most of the unsafe level of enzyme cholinesterase reported sweating (47.5%). Follow by irritation of the throat (37.5%) and muscle cramp (35.0%). The results can be used as a database for blood enzymes erythrocyte cholinesterase levels. This research suggested that public health education training programs including knowledge regarding to pesticides use and exposure, appropriate personal protective equipment (PPE) for tobacco farmers to improve their ability to handle pesticide and quality of life.

**P03.2310. Estimating of the Costs of Occupational Injuries and Illnesses from Agricultural Work in Thailand**

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Abstract: Injured workers in agricultural sector in Thailand were absented in workers' compensation system as they have long been excluded from labor department's database. Due to Lack of neither record of injured workers nor cost of injuries and illnesses in Agricultural works, therefore no interest to decision makers in the governmental authority to do anything to address this issue. This study propose an alternative method to analyze the costs of occupational injuries and illnesses by estimating monetary values of lost productivity allocation based on injury or illness related production function and the output of agricultural commodities.

### **P03.2320. Chronic Diseases in Agricultural Workers with Different Pesticide Exposure in Mauco, Chile**

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**Abstract:** Introduction the Maule Cohort (MAUCO) is a population-based cohort in an agricultural county in central- southern Chile. The prevalence of chronic diseases and risk factors among agricultural workers (AW) from MAUCO were examined in accordance to different levels of exposure to pesticides. Methods People aged 38 to 74 were eligible. All participants answered an epidemiological survey, received standard medical evaluations, and answered information on the use of pesticides. We compared prevalence of chronic conditions and risk factors among AW no pesticide applicators (n=1527) and AW pesticide applicators (n=875). We considered as control groups all workers on any activity other than agriculture (n=2,287). Results Among 4,689 AW identified in MAUCO, 51% were men; 18.7% reported direct exposure to pesticides as applicators (32% of men and 4.7% of woman). 64% had less than 8 years of schooling. Among men, the prevalence of binge drinking and overweight were higher among male applicators (45.2% and 25.9%) than in the control group (40.8%; 31.7%). 56.4% of male applicators had been exposed to pesticide for more than 10 years and only 15.5% reported use of personal protective equipment (vs control group both were 0%). Medical diagnoses of hypertension, diabetes and cancer were lower among applicators. A respective risk of 21.8%, 10.7%, and 4.3% were recorded for male applicators vs 23.2%, 13,8%, and 5.4% in males AW not exposed to pesticides. In male, only respiratory disease is higher in applicators (4.3%) than AW no exposed (2.9%). OR and IC 95%, adjusted by age were: hypertension 0.8 (0.7-1.2), diabetes 0.7(0.5-1.02), cancer 0,7 (0.3-0.8), and respiratory disease 1.5 (0.8-2.9). Conclusions Even though, applicators had more risk factors, they had lower prevalence of chronic condition than non-agricultural workers. Nevertheless, the difference did not reach statistical significance. Further analysis is need to explore the healthy workers bias in our participants.

### **P03.2330. Mitochondrial DNA Damage in Spermatozoa of Faroese Men Exposed to Organochlorines**

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Abstract: Mitochondria are essential for sperm function and fertility, serving such functions as cellular energy for motility, apoptosis during spermatogenesis and capacitation. Interest in mitochondria has increased in epidemiologic studies but there has been no focus on sperm so far. Few mechanisms have been explored why sperm counts have been declining over the last 40 years. We sought to demonstrate the relationship between mitochondrial DNA and sperm health. This pilot study used mitochondrial DNA damage and copy number to assess negative effects of exposure to organochlorines on sperm. Semen and serum samples from men (n=50) 22-44 years old who participated in Faroe Islands health studies were randomly selected from the first and third tertiles (n=25 for each tertile) of serum concentrations p,p'-DDE and PCB congeners 118, 138, 153, and 180 (adjusted for total lipids). Mitochondrial DNA damage was determined using QPCR that measures the decrease in DNA amplification due to the presence of DNA lesions that stalls the progression of DNA polymerase. Validated primers that amplify a long sequence were used to increase the probability that a DNA lesion will be present. The average mtDNA copy number of per sperm cell in each sample was measured using previously published primers. Amplification progress was followed using cyber green dye and amplification specificity was controlled by using temperature melting curves. Mitochondrial DNA content was calculated using the difference in cycle thresholds between nuclear and mitochondrial DNA. Multivariate adjusted Poisson models were used to estimate the relationship between organochlorine exposure and DNA damage. Age, abstinence time, smoking status, were all potential confounders controlled for in the adjusted analysis. Incidence rate ratios (IRRs) and 95% confidence intervals were calculated for each model. We expect to see an increase in mitochondrial DNA damage in sperm of men with higher exposures to p,p'-DDE and PCBs.

### **P03.2340. Urinary Inorganic Arsenic Concentration and Type 2 Diabetes Mellitus and Hypertension Development: A Population-Based Analysis in Arica, Chile**

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**Abstract:** Introduction: Studies that evaluated the association between type 2 diabetes mellitus and hypertension has been consistent in population exposed to high levels of arsenic. However, the evidence is no clear regarding low levels of exposure. The aim of this study was to explore the association between the concentration of inorganic arsenic in urine and the development of type 2 diabetes mellitus and hypertension. Methods: Data analysis of 10.340 individuals over the age of 14, of the population register of people exposed to polymetals, evaluated between 2009 and 2015. Outcome variable: Self-report of diagnosis of type 2 diabetes mellitus (T2DM) and hypertension (HBP). Exposure variable: Concentration of inorganic arsenic in urine. To evaluate association, we used multiple logistic regression models adjusted for creatinine, age, and body mass index. Results: Average age 40 years. The prevalence of diabetes was 8% (CI95% 0.073-0.085) and hypertension 15% (CI95% 0.143-0.159), (31% lost data). The median of inorganic arsenic was 18 µg/L (p25-p75 11-27 µg/L). The adjusted model showed a modest association between inorganic arsenic and T2DM (OR: 1.008, 95% CI 1.003-1.013). Regarding the relationship with HBP, the association was not significant (OR: 0.99, IC95% 0.993-1.004). Conclusion: The results support the hypothesis that low levels of arsenic exposure could be associated with T2DM; however, should be considered with caution due limitations as the way of measuring the outcome variable, the % of lost data and the lack of information from other confounding.

### **P03.2350. Effects of Early Life Arsenic Exposure on Renal Function in Adolescents and Young Adults in Rural Bangladesh**

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**Abstract:** Background: Long term exposure to arsenic through drinking water has been reported to increase the risk of chronic kidney diseases in adults. However, information on the impact of early life arsenic exposure on renal function in adolescents is limited. This study evaluated kidney function in adolescents and young adults exposed to elevated level of inorganic arsenic in utero and in the first five years of life in rural Bangladesh. Methods: The study was conducted in rural Bangladesh, Matlab. A cohort of 200 adolescents and adults now aged 11-22 years were enrolled of which 107 were exposed to water arsenic concentration over 400µg/L during prenatal life and early childhood (exposed group) and 93 had a water concentrations of less than 10 µg/L (unexposed group). Renal function was assessed by the level of serum beta 2 microglobulin, a marker of early renal injury. Serum beta 2 microglobulin concentration was determined by the Immunoturbidimetric assay. Participants were categorized as having normal or elevated β2MG based on the age and sex specific reference values. Results: The mean age was 14.9± 2.8 years. In an adjusted model, exposed individuals had nearly 2-fold higher risk of elevated beta 2 microglobulin compared to the unexposed [odds ratio (OR) =1.98; 95% Confidence interval (CI): 1.12-3.49; 1-tailed p =0.010]. The effect was more pronounced in females (OR=3.02, 95% CI: 1.29-7.10; 1-tailed p=0.006) with little evidence in males (OR=1.36, 95% CI: 0.62-3.00; 1-tailed p =0.222). Conclusions: We found evidence of modest impairment of kidney function as indicated by elevated serum beta 2 microglobulin among the arsenic exposed individuals. Females showed greater evidence of arsenic induced renal injury. We plan to follow this cohort to assess the progression of changes in kidney function as they become older.

### **P03.2360. Arsenic in Drinking Water Interventions: Systematic Review of Community Based Approaches in Bangladesh**

Ondine von Ehrenstein

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**Abstract:** Background: Arsenic in drinking water remains a major public health concern in many countries with many millions exposed to concentrations magnitudes above the WHO recommended drinking water guideline. In spite of the wide scale acknowledgement of adverse effects on population health, millions of people in the affected regions continue to drink arsenic contaminated water. The purpose was to systematically review published studies on community/population based drinking water interventions to mitigate arsenic exposure. Methods: We systematically searched literature using the following data bases: Pub Med, Web of Science, and the World Health Organization Library, and grey literature. The inclusion criteria included: A population sample of at least 50 subjects, arsenic exposure via drinking water and reporting of arsenic concentrations, reported intervention. Findings: The search revealed over 4000 publications derived by our search terms. All titles were screened and if applicable the abstracts by 2 separate investigators. This resulted in inclusion of 82 publications that were further evaluated. Less than 20 of these publications involve community/population based interventions, and only 10 of the publications concerned low/middle income countries; these were mainly located in Bangladesh. Based on these findings, research gaps, and directions for further implementation research were identified. Interpretation: Arsenic in drinking water continues to be a threat to population health in many nations involving many millions of people globally affecting particularly lower income populations. In spite of a large body of evidence on the severe health effects related to arsenic, efforts to reduce population exposure via drinking water remain insufficient. Implementation research is needed to identify effective population based interventions and mitigation approaches to prevent arsenic exposure on a large scale.

**P03.2370. Geographic Variation and Contributions of Rurality and Area-Level Socioeconomic Circumstances to Incidence of Alzheimer's Disease over 11 Years: Multilevel Discrete-Time Event History Analysis of a Cohort of 261,669 Australians Aged 45 Years and Older**

Thomas Astell-Burt

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**Abstract:** Background Longitudinal studies of environmental risk factors for Alzheimer's disease are scarce. Methods Data for this study comprised 261,669 participants in the Sax Institute's 45 and Up Study. Diagnoses of Alzheimer's disease were identified using the first recorded prescription of a cholinesterase inhibitor from recruitment to December 31st 2016, linked from the Pharmaceutical Benefits Scheme (provided by the Department of Human Services and part of Australia's universal health insurance). Participants with a cholinesterase inhibitor record prior to baseline were excluded. Multilevel discrete-time event history Poisson regressions (i.e. multilevel survival analysis) was used to measure geographic variation in Alzheimer's disease incidence and to assess contributions made by rurality and area-level socioeconomic disadvantage. Models were adjusted for age, gender and educational attainment. Results A total of 3,046 participants (1.16%) were diagnosed with Alzheimer's disease during the study. A median rate ratio of 1.48 indicated meaningful geographic variation. Alzheimer's disease risk was lower in more versus less disadvantaged areas (incidence rate ratio 0.85, 95% confidence interval 0.77 to 0.95) and in outer regional or remote areas compared to major cities (0.81, 0.67 to 0.97). Rurality and area-level disadvantage explained 3% of the geographic variation denoted by the median rate ratio. Gender did not modify these associations, nor were there differences in the association with area-level disadvantage by rurality. Conclusion Alzheimer's disease risk in this study is higher in more affluent, urban communities. Since the vast majority of the geographic variation was not explained by rurality or socioeconomic circumstances, other environmental factors warrant investigation.

### **P03.2400. Sex/Gender Differences in Cardiovascular Mortality Associated with Environmental Stressors: Systematic Review and Meta-Analysis**

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Abstract: Epidemiological studies of environmental stressors associated with cardiovascular health often show different effect estimates for males and females, but results are far from being consistent. Furthermore, there is a need to disentangle whether this modification is attributable to the biological sex, to gender including social role or cultural norms or an interplay of both. Our objective is to evaluate the current state of integrating sex/gender into environmental epidemiology and to quantify the sex/gender specific effects of ambient air pollution, air temperature and noise on cardiovascular mortality. We conducted a systematic literature search using the electronic databases PubMed and Web of Science (WOS). Publications in English or German between 2000 and 2017 which provide sex/gender specific effect estimates for short- and long-term associations between particulate matter with a diameter <2.5µm (PM2.5) and <10µm (PM10), nitrogen dioxide (NO2), ozone, air temperature as well as noise and cardiovascular mortality were screened. We will assess studies' integration of sex and gender with regard to conceptualization and operationalization of sex/gender, reporting of male and female specific baseline characteristics, exposure and health data as well as discussion of sex/gender specific results. After study quality rating sex/gender specific effects will be quantified by applying meta-analytic tools. Of 660 and 394 identified articles in PubMed and WOS, respectively, 76 studies met our inclusion criteria. Most studies dealt with PM2.5 (N=29), followed by PM10 (26), NO2 (26), air temperature (25) and Ozone (10). Only one study was found regarding noise. Preliminary results show that studies generally used a dichotomous category "male/female", lacked a clear conceptualization and therefore missed a gainful discussion of results. In the next steps we will continue with the extraction of necessary information and preparation of meta-analysis where possible.

### **P03.2410. Towards a Systematic Review of Environmental Injustice in Canada: National Patterns of Environmental Risks and Benefits**

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Abstract: The environmental justice paradigm, now more than three decades old, is gaining new momentum by expanding to include a wider range of issues, broader geographic scope, and greater focus on potential solutions. However, to date, most research on environmental injustice in Canada has focused on specific case studies (e.g., large urban centres, Indigenous communities), with only a small number of studies focusing on national or regional-scale patterns. As part of a larger interdisciplinary effort, combining quantitative, qualitative, and legal analysis, this research will provide a deeper understanding of uniquely Canadian environmental injustice patterns and identify potential case studies for future work on the processes that create and perpetuate these injustices. In this preliminary analysis, we describe how exposure to selected environmental hazards (e.g., ground-level ozone, water advisories) and access to environmental benefits (e.g., green space) varies across demographic and socioeconomic characteristics in Canada, at a national-scale. We apply methodologies (described below) from recent national-scale analyses of NO<sub>2</sub> and fine particulate matter in the US and Canada to data from the 2016 census and existing environmental data sets from the Canadian Urban Environmental Health (CANUE) Research Consortium, and from federal and provincial governments. Population variables considered include Aboriginal and racialization status, immigrant status, socio-economic status, age, stratified by urban and rural residence. We compute descriptive statistics (Student's t-test and Cohen's d) to evaluate the significance and magnitude of differences between selected groupings. Finally, we situate these results within our larger framework for a systematic analysis of environmental injustice in Canada by discussing linkages to law, policy, and social movements that may contribute to, or remedy, these observed patterns.

### **P03.2420. Different Degrees of Environmental Contamination by Trace Metals from Mining Activities between DR Congo and Zambia in the African Copperbelt**

Célestin Banza Lubaba Nkulu

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**Abstract:** The African Copperbelt covers an area across the border between DR Congo and Zambia and has been a site of intense mining of copper and cobalt. To compare the environmental contamination by trace metals between the two countries, we sampled surface waters and various types of food crops (leafy vegetables, fruits, grains, roots and tubers) collected from kitchen gardens and fields in relevant locations in the (former) Katanga province in DR Congo (Kipushi, Likasi, Lubumbashi) and the Copperbelt Province in Zambia (Chingola, Kitwe, Luansha). The vegetables samples were rinsed with water, oven-dried at 70°C for 24 hours, crushed, and destroyed in ultrapure nitric acid. Trace metals were quantified by Inductively Coupled Plasma Optical Emission Spectrometry. Median (IQR) concentrations ( $\mu\text{g/L}$ ) of Mn [80 (18-2220) vs 13 (8-43)], Co [80 (22-2346) vs 2 (0.8-8.6)], Cu [138 (28-3206) vs 5 (1-18)], As [2 (0.5-20) vs 0.2 (0.1-0.2)], Cd [0.4 (0.1-5.7) vs 0.01 (0.00-0.02)], Pb [14 (2-311) vs 0.1 (0.0-0.7)], U [0.68 (0.14-3.12) vs 0.03 (0.00-0.17)] were 6 to 178 times higher in DRC (n=37) than in Zambia (n=42). In food stuffs, median concentrations (mg/kg) of Co [6 (2-16) vs 1.5 (0.8-3.0)], Cu [62 (25-166) vs 34 (20-55)], Cd [0.9 (0.3-2.3) vs 0.2 (0.1-0.4)], Pb [1.1 (3.9-10.4) vs 0.5 (0.2-1.0)], U [3.1 (1.5-5.8) vs 1.9 (0.9-3.7)] were 1.7 to 5.4 times higher in DR Congo (n=145) than in Zambia (n=135). The differences in trace metal contamination of food intended for human consumption between the two neighbouring provinces located in the same mining area of the African Copperbelt indicate that environmental pollution by mining activities is higher in DR Congo than in Zambia. The exact causes for this situation remain to be elucidated but increased efforts are needed to uphold and enforce environmental legislation and protect human health in DR Congo.

**P03.2430. Effects of Mothers' Language and Culture Backgrounds on Developmental Delays: A Nationwide Study on Children Born to Immigrant Mothers in Taiwan**

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Abstract: Transnational marriages are common as a result of globalization, and immigrant mothers face various degrees of differences in language and culture backgrounds. A mother has a large influence on the development of her children, but the effects of immigrant mothers' language and culture backgrounds on developmental delays (DD) of children are seldom studied. To evaluate the potential effects, we analyzed data from the national registry of DD in Taiwan from 2010 to 2013 and compared the incidence of DD in young children born to mothers from China, Vietnam, and Indonesia, where most of the immigrant mothers in Taiwan come from. We included 4604 new cases of DD in children under 7 years of age born to immigrant mothers during the study period. The incidence rates showed an increasing trend among children born to mothers from China, Vietnam, and Indonesia ( $p < 0.01$  in all years). Using Vietnam as the reference, we found the incidence rate ratios in children born to mothers from China ranged from 0.65 to 0.73, and those in children born to mothers from Indonesia ranged from 1.04 to 1.26. The findings support the important role of mothers' language and culture backgrounds in the development of children.

**P03.2450. Prevalence of Asthma-Related Symptoms in Adolescents Living near Industrial Animal Feeding Operations in Eastern North Carolina (U.S.A.)**

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Abstract: Animal feeding operations (AFOs) generate substantial air pollution; proximity has been associated with asthma-related illness in children. In North Carolina, swine and poultry AFOs are most common. We examined the relation between adolescents' home exposure to swine and poultry AFO-related air pollution and prevalence of asthma-related symptoms. The Rural Air Pollutants and Children's Health study enrolled 340 students from three eastern North Carolina middle schools in 2009. Participants self-reported demographics, health, and respiratory symptoms. We developed novel exposure indices to estimate home exposure to air pollution from swine and poultry AFOs. Home exposures were indexed by geocoded address, orthoimagery-derived size and location of barns within 2 miles, and predominant past-year wind direction. Indices were categorized (low/middle/high) for swine and poultry separately. We estimated prevalence differences (PD) for current wheeze and asthma by exposure category, using linear binomial regression with inverse-probability weights to control confounding by gender, age, school, time outside, lunch assistance, passive smoke exposure, and livestock exposure (ie, chores). Of 326 participants with complete data, 93% lived within 2 miles of at least one AFO. Prevalence of current wheeze and current asthma were 24.0% and 10.6%, respectively. In crude data, neither swine nor poultry exposure index was associated with current wheeze or current asthma. After controlling for confounding, middle and high swine exposure index categories were associated with higher prevalence for both outcomes compared to the lowest category (current wheeze PD per 100 adolescents: 11.3, 95% CI: 2.6, 20.0; current asthma PD: 5.9, 95% CI: -0.1, 11.9). Using a novel exposure metric and rich covariate data, we observed higher prevalence of current wheeze and asthma with higher swine AFO exposure. Future research should examine potential heterogeneity by sociodemographic or geographic factors.

### P03. Prenatal and Early Life Exposures and Effects 3

#### **P03.2470. Metallome-Wide Association Study of Maternal-Fetus Interface Metabolism Dysfunction in Gestational Diabetes Mellitus**

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**Abstract:** A broad set of elements has been linked to gestational diabetes mellitus (GDM); the previous study also acknowledged some metabolic biomarkers in meconium can provide the biology of GDM. This work was to assess a set of elements' associations with GDM and infer the causality by using the maternal-fetus interface surrogating sample of meconium. We conducted a case-control study nested on the cross-sectional retrospection of 1359 recruitments from the Xiamen Maternity and Child Care Hospital. The ICP-MS and ICP-OES was used to characterize the meconium metallome of 23 elements. The associations for some GDM-related elements, GDM-oriented metabolic biomarkers and GDM incidence were assessed by using redundancy analysis and Correlation-Adjusted corRelation. Mediation analysis was in further used to test the metabolic biomarker mediation between the elements and GDM incidence. The significant associations of eight elements with GDM incidence were observed, the risk elements are Al, As, Ba, Cd, Hg, and Sn and the preventive elements are Ca and V. Among them, As, Cd, Ba, and Ca can also explain the variation of GDM-oriented metabolites. 69% of the total variance of GDM incidence can be explained by all investigated factors and the elements had an independent predictive power of 16%. The investigated elements can also explain 39.5%, 26.58%, and 23.78% of the total variance of argininosuccinic acid, oxotrihydroxyleukotriene B4 and taurodeoxycholic acid, respectively, which are the top three metabolic determinants and can explain about 45% of the total GDM incidence. From more to less, the associations of Cd, Ba, Ca and As with GDM incidence have been mediated by the metabolic biomarkers. Ba, As and Cd aggravate GDM occurrence while Ca play the preventive role; the metabolic biomarker involved lipid metabolism and ALANO pathways may imply the elements' biological action on GDM. Notably the toxic effect of Ba and the beneficial effect of Ca on GDM have not been attended before.

**P03.2480. Associations between Maternal Exposure to Bisphenol A or Triclosan and Gestational Hypertension and Preeclampsia: The MIIREC Study**

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**Abstract:** Background: Little is known about the association between bisphenol A (BPA) or triclosan (TCS) exposure and hypertension in pregnancy. Objective: To investigate potential associations between maternal urinary concentrations of BPA or TCS and gestational hypertension and preeclampsia. Methods: Among 1909 pregnant women participating in the (Maternal-Infant Research on Environmental Chemicals (MIREC) Study, urinary concentrations of BPA and TCS were measured in the first trimester by liquid chromatography-tandem mass spectrometry using isotope dilution. Blood pressure was measured during each trimester. Multinomial regression was performed to estimate the adjusted odds ratio (aOR) and 95% confidence intervals (CI) for the associations between these phenols and gestational hypertension and preeclampsia. Results: BPA urinary concentrations were similar according to hypertension status: The median (interquartile range) concentrations were 0.97 µg/L (0.40, 2.00), 1.10 µg/L (0.40, 1.90), and 0.80 µg/L (0.35, 1.70) for women with gestational hypertension, those with preeclampsia and normotensive women, respectively (p = 0.075). For TCS, the values were 10.04 µg/L (2.56, 76.26) for the group with gestational hypertension, 6.48 µg/L (1.48, 67.94) for those with preeclampsia and 8.56 µg/L (2.16, 67.35) for normotensive women (p = 0.559). Compared with the lowest tertile, BPA and TCS were not associated with gestational hypertension (aOR for BPA > 1.30 µg/L = 1.00; 95% CI: 0.54-1.81 and aOR for TCS > 32.6 µg/L = 1.41; 95% CI: 0.83-2.37) or preeclampsia (aOR for highest tertiles were 1.26; 95% CI: 0.53-2.97 and 0.68; 95% CI: 0.31-1.48, respectively). Conclusion: BPA and TCS urinary concentrations measured during the first trimester of pregnancy were not associated with gestational hypertension or preeclampsia. Additional studies are required to confirm our results.

### **P03.2490. Prenatal Blood Manganese Levels and Postpartum Depression among Women in Mexico City**

Nia McRae

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**Abstract:** Introduction: Previous studies have shown a positive association between manganese and depression symptoms. The effect of elevated manganese levels on depression may apply to postpartum depression as well due to postpartum depression being a subtype of depression. We examined the association between prenatal blood manganese levels and postpartum depression among women in Mexico City. Methods: Study subjects were 561 women from the PROGRESS birth cohort in Mexico City. Blood manganese levels were measured at 2nd and 3rd trimester, as well as delivery. The Edinburg Postnatal Depression Scale was used to assess postpartum depression. Adjustments were made for maternal age, prenatal stress, prenatal depression, education, socioeconomic status, and contemporaneous blood lead levels. Poisson regression was used to analyze depression scores. Results: Among our study participants, 17.11% reported having postpartum depression symptoms. In the crude analysis, blood manganese levels during the 3rd trimester, prenatal stress, and prenatal depression had a positive association, and women with more than a high school education had an inverse association with postpartum depression symptoms. In the adjusted model, blood manganese levels averaged at 2nd and 3rd trimester ( $\beta$ : 0.15, 95% CI: 0.02-0.28) and blood manganese levels during 3rd trimester ( $\beta$ : 0.13, 95% CI: 0.04-0.21) in which the adjusted lead measure was lead in the tibia bone at 1 month postpartum and blood lead at 3rd trimester, respectively, had a positive association with postpartum depressive symptoms. Higher blood manganese levels averaged at the 2nd and 3rd trimester ( $\beta$ : 0.14, 95% CI: 0.02-0.26) had a positive association with postpartum depression symptoms in which the adjusted lead measure was averaged at 2nd and 3rd trimester. Conclusion: The results of our study suggest that elevated prenatal blood manganese levels may increase the prevalence of postpartum depression symptoms.

### **P03.2500. Prenatal Cadmium Exposure Associates with the Expression of Placental Imprinted Genes Overall, and in Sex-Specific Patterns**

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Abstract: Prenatal Cd exposure has been recognized to restrict growth, and male and female fetuses may have differential susceptibility to the developmental toxicity of Cd. Imprinted genes, which exhibit mono-allelic expression based on parent-of-origin, are highly expressed in placental tissues, contribute to fetal growth development and some of which are also expressed in sex-specific patterns. We aimed to identify whether prenatal Cd is associated with the expression of imprinted placental genes, overall or in fetal sex-specific patterns, across two independent epidemiologic studies. We regressed the placental expression levels of 72 putative imprinted genes on placental log-Cd concentrations while adjusting for maternal age, sex, smoking history, and educational attainment. These models were performed within study- and sex-specific strata in the New Hampshire Birth Cohort Study (NHBCS, n=326) and the Rhode Island Child Health Study (RICHS, n=214). We then used fixed-effects models to estimate the pooled associations across strata and examined heterogeneity in the associations by fetal sex. We identified 6 imprinted genes that were differentially expressed with log-Cd at the Bonferroni-adjusted alpha ( $p$ -values < 0.00069). Of particular note, higher Cd concentrations were associated with higher expression of GAA ( $p$ -value = 0.0000033) and DLX5 ( $p$ -value = 0.000012), and lower expression of H19 ( $p$ -value = 0.00018) across study and sex-specific strata. We also found that the placentae of female fetuses appeared more susceptible to Cd-associated increased imprinted expression. The differential regulation of these imprinted genes in association with prenatal Cd exposure may be involved in the overall developmental toxicity and contribute to the apparent unique Cd-responses of male and female placentae.

**P03.2510. Contribution to the Understanding of Biologic Concentrations of Metals in the Newborns in an Urban Area from Rio de Janeiro, Brazil**

Monica Araujo

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**Abstract:** Background/Aim: Environmental exposure to heavy metals in urban areas has been associated with adverse birth outcomes such as spontaneous abortion, stillbirth, preterm birth, low birth weight, small for gestational age birth, and lower head circumference. To evaluate prenatal exposure and to test viability for a birth cohort study, a pilot study was conducted in newborns at the School Maternity of the Federal University of Rio de Janeiro (ME-UFRJ). The aim of this study is to evaluate exposure to metals of interest to Public Health (Lead, Mercury, Arsenic and Cadmium) in newborns in an urban area. Methods: During the months of October and November of 2017, all pregnant women attended at ME-UFRJ, over 16 years of age, were invited to participate in the project. Were collected 1) socioeconomic, cultural, leisure and living conditions of the parents 2) Maternal biological samples (blood, urine and hair) 3) Cord blood, anthropometric data, APGAR and urine of the newborn. Results: Of the 209 pregnant women attended, 142 accepted to participate (67.9%), 4 of whom were twin pregnancies (2.8%). From October / 2017 to February / 2018, there were 131 births (92.3%), and cord blood was collected from 122 births (85.9%). Expected results: The data analysis and the laboratory results will be available in May 2018 and will be presented at the conference Conclusion: This study may contribute to the increase of knowledge regarding exposure to metals, and its predisposing factors or conditions, of newborn in an urban area in Brazil.

### **P03.2520. Urinary Measures of Glyphosate and Oxidative Stress in Pregnant Women**

Shahid Parvez

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**Abstract:** Glyphosate (GLY) is the most heavily used herbicide in the United States. Its residues found in all environmental mediums, major crops, and food items that are daily consumed by Americans. In-vivo and in-vitro studies suggest GLY disrupts important endocrine mediated pathways, and causes oxidative DNA damage in animal and human breast epithelial and placental cells. Our published birth cohort study provides first urinary measures of GLY in a regional cohort of 71 pregnant women, and confirms 93% detection rate, with significant risk of shorter gestation length ( $r=-0.28$ ,  $p=0.01$ ). Our findings suggest that GLY exposure may be prevalent in millions of pregnant women, and places pregnancies and newborns at risk. Therefore, a follow up study was designed to examine whether GLY increases the risk of oxidative DNA damage in human pregnancies, a known pathophysiology indicator of many reproductive complications, including shortening of pregnancy. Our central hypothesis is that higher urinary GLY levels will be correlated with oxidative biomarkers. We measured 8-hydroxy-deoxyguanosine (8-OHdG) and 8-iso-prostaglandin F2a (Isoprostane) as the urinary biomarkers of oxidative stress in the stored urine specimens of pregnant women. We measured 8-OHdG using immunoassay, and Isoprostane using liquid chromatography-mass spectrophotometry. Currently, we are analyzing the generated data to develop correlations between the measured levels of urinary GLY and oxidative biomarkers. This study offers innovation as it is the first time GLY exposure levels will be correlated with oxidative stress biomarkers in human pregnancies, which are currently unknown and will serve as a basis for future investigations.

**P03.2530. Increased Risk of Phthalates Exposure for Recurrent Spontaneous Abortion in Reproductive-Aged Women: Taiwan Female Infertility Study (TIFF)**

Po-Chin Huang

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**Abstract:** Background/Aim Recurrent spontaneous abortion (RSA) is the termination of pregnancies, usually before 20 weeks of gestation. Some studies indicated that phthalates may involve in the pathogenesis of RSA, and that Taiwan's reproductive-aged women were still exposed to high levels of DEHP and DBP after 2011 DEHP exposure episode. We aimed to assess the risk of phthalates in Taiwanese women with RSA using a case-control study design. Methods We recruited 103 RSA patients and 76 controls from the department of obstetrics and gynecology in a hospital in southern Taiwan from 2013 to 2017. Urine samples were analyzed for 11 phthalate metabolites through LC/MS-MS; subsequently, principal component analysis (PCA) and agglomerative hierarchical clustering analysis were performed to determine the main sources of phthalate exposure. Multivariate logistic regression was used to determine the RSA risk. Results Median levels (ng/mL) of mono-n-butyl phthalate (MnBP), mono-iso-butyl phthalate (MiBP), mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP), mono-(2-ethyl-5-carboxypentyl) phthalate (MECPP),  $\Sigma$ DBPm, and  $\Sigma$ DEHPm were 3.1/27.2, 5.3/9.8, 8.1/11.4, 9.5/12.9 ng/mL, 0.10/0.18 nmol/mL, and 0.12/0.15 nmol/mL respectively, in control/RSA. PCA revealed three primary components of phthalate exposure: DEP, DBP, and DEHP. Plastic food container use and medication use were identified as the main phthalate exposure sources. After adjustment for creatinine, age, age at menarche, educational level, plastic food container use, and food preservation bag use, we observed significantly high odds ratios for RSA: 3.15 ( $p=0.03$ ), 3.31 ( $p=0.04$ ), and 2.57 ( $p=0.07$ ) in the third tertile for MiBP,  $\Sigma$ DEHPm, and  $\Sigma$ DBPm, respectively. Conclusions Our findings support the hypothesis that exposure to phthalates increases RSA risk in Taiwanese women. The development of the strategy to avoid using phthalate coatings for oral medications and plastic products among reproductive-aged women should be emphasized.

**P03.2540. Pioglitazone Increases the Number of Ultrasonic Vocalization Impaired by Prenatal LPS in Rats, an Effect Not Related with Insulin and Leptin**

Thiago Kirsten

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Abstract: Previous investigations by our group have demonstrated that prenatal exposure to lipopolysaccharide (LPS), which mimics infections by gram-negative bacteria, induces autistic-like behaviors. We used our rat model to test a possible treatment for autism. We selected pioglitazone because although it was designed as an anti-diabetic drug (insulin effect), it also exerts anti-inflammatory effects. Juvenile offspring were daily treated with pioglitazone and 50 kHz ultrasonic vocalization was studied because of its relation with communication and autism. Biomarkers linked to autism and/or pioglitazone were also studied to try to understand the mechanisms involved: insulin, and leptin. Prenatal LPS exposure reduced both the number and the total time of vocalizations, compared with the data from the control group. Post-treatment with pioglitazone increased the number of ultrasonic vocalization in the rats prenatally exposed to LPS, i.e., both doses of pioglitazone (0.25 or 1.0 mg/kg/day) increased the number of vocalizations, compared with the LPS group. However, only the pioglitazone treatment of 1.0 mg/kg/day associated with LPS affected insulin and leptin plasma levels, increasing it compared with the levels exhibited by the other groups. In conclusions, prenatal LPS exposure induced communicational abnormalities in juvenile rat offspring. Daily postnatal pioglitazone treatment blocked the ultrasonic vocalization deficits. The communicational abnormalities induced by prenatal LPS as well as the beneficial effects of pioglitazone seem not to be related with insulin and leptin. Capes and Unip.

### **P03.2550. Contrasting Associations between Exposure to Environmental Marine Pollutants and Reports of Immune System Disorders in Greenlandic Children**

Youssef Oulhote

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**Abstract:** Background: Early-life exposures to environmental contaminants may modulate the development of immune system. Objective: To examine the associations between exposure to marine pollutants and prevalence of atopic diseases, antibodies and IgE concentrations. Methods: We examined 367 Greenlandic children aged 7 to 12 years from the IVAAQ and INUENDO pregnancy cohorts. Concurrent concentrations of Polychlorinated biphenyls (PCBs), Mercury (Hg), Hexachlorobenzene (HCB),  $\beta$ -hexachlorocyclohexane ( $\beta$ -HCH), and perfluoroalkyl substances (PFASs) were measured in children's blood. Diagnoses of asthma, allergy, eczema, rash, and hayfever were ascertained based on the standardized International Study of Asthma and Allergies in Childhood. We also measured Diphtheria and Tetanus antibodies and IgE concentrations in children's blood. We used generalized mixed effects models to estimate the associations between chemical concentrations and allergic diseases and antibodies concentrations. Results: Prevalence of asthma, allergy, eczema, rash, and hay fever was 14%, 13%, 14%, 17%, and 4%, respectively. We found positive associations between higher concentrations of HCB (Odds Ratios [OR] for a two-fold increase = 1.43; 95% Confidence Interval [CI]: 1.03, 1.98), Perfluorononanoic Acid (PFNA) (OR = 1.62; 95% CI: 1.01, 2.60), and Perfluorodecanoic Acid (PFDA) (OR = 1.33; 95% CI: 0.99, 1.81) and asthma prevalence. In contrast, we found negative associations between HCB, PFASs, and Hg, and prevalence of eczema. For instance, a two-fold increase in PFOS and PFOA concentrations was associated with 0.40 (95% CI: 0.24, 0.65) and 0.31 (95% CI: 0.14, 0.67) lower odds of eczema. Similar negative associations were observed for the prevalence of rash. No pattern of associations was found with IgE and antibodies concentrations. Conclusions: Despite the contrasting observed associations, these findings provide further evidence on the potential immunomodulatory effects of marine pollutants.

### **P03.2570. Childhood, Adolescence, and Agrochemicals: A Minefield to Inhabit**

Paulo Paz de Lima

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Abstract: Paulo Junior Paz de Lima - E-mail: [pjuniorpl@usp.br](mailto:pjuniorpl@usp.br) Telma de Cassia dos Santos Nery - E-mail: [telma.nery@hc.fm.usp.br](mailto:telma.nery@hc.fm.usp.br) For a decade, since 2008, Brazil has been among the top buyers of agrochemicals in the world. Its consequences include high rates of suicide, congenital malformations, high prevalence of mental illness, and high incidence of intoxication by agrochemicals in people aged from <1 to 19. Objective: investigating cases of intoxication from agrochemicals in Brazilians aged from <1 to 19. Methodology: Cross-sectional descriptive study, from the cases of notifications of intoxication by agrochemicals registered by SINAN/MS and SINITOX/Fiocruz in people aged from <1 to 19 in the period between 2005 and 2015. Results: Between 2007 and 2015, SINAN/MS was notified of 21,840 cases of intoxication by agrochemicals used in agriculture, at home, and in public health and by rodenticides. Of these, 6,075 cases were caused by agrochemicals of agricultural use; 9,607 victims were aged 15 to 19 and 1,509 were under 1 year of age. SINITOX registered 44,687 cases of intoxication by agrochemicals in people aged from <1 to 19. Discussion: Victims of intoxication by agrochemicals are not necessarily economically active. Exposure to and intoxication by agrochemicals are part of the reality of children since an early age; many are intoxicated while still in the womb of their mothers, who are rural workers. Conclusion: Intoxication by agrochemicals in children and teenagers can have severe lasting effects on physical or mental health, leading to learning difficulties if it happens during a stage of development of the body, the mind, and the personality. It is a public health issue that must be addressed carefully by governments, health professionals, educators, and researchers in order to develop specific studies with this population. Keywords: childhood, adolescence, agrochemicals, intoxication, health.

**P03.2580. Household Renovations before and during Pregnancy Are Associated with Preterm Birth and Low Birth Weight in China: A Multicenter, Retrospective, and Observational Study**

Wei Liu

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**Abstract:** Background: Few studies have investigated the associations between early household environmental exposures and adverse birth outcomes. Here we analyzed associations of household renovation in the year before pregnancy and during pregnancy with preterm birth (PTB, gestational age <37 weeks) and low birth weight (LBW, birth weight <2500 g). Methods: A retrospective cohort study was conducted for children from eight large cities of China (Beijing, Shanghai, Nanjing, Changsha, Wuhan, Chongqing, Urumqi, and Taiyuan) during 2010-2012. Parents responded to questions about household renovation and their child's gestational age and birth weight. Multiple regression and two-level (city-child) mixed-effect logistic regression analyses were performed to investigate the target associations. Results: A total of 35,807 subjects were analyzed. Herein 16.9% and 4.5% subjects had household renovation in the year before pregnancy and during pregnancy, respectively. A total of 4.1% and 2.6% children were PTB and LBW, respectively. In the multiple logistic regression analyses, household renovation in the year before pregnancy was significantly associated with LBW (adjusted odds ratio with 95% confidence intervals: 1.23, 1.01-1.50; p-value=0.036). Household renovation during pregnancy was significantly associated with PTB (1.28, 1.01-1.69; 0.048). Similar associations were found in the two-level logistic regression analyses. Conclusions: Household renovation before pregnancy could be a risk factor for LBW, while household renovation during pregnancy could be a risk factor for PTB. Avoidance of early household renovation would be an effective intervention to reduce adverse birth outcomes.

**P03.2590. Prenatal Exposure to Perfluoroalkyl Substances (PFASs), Polybrominated Diphenyl Ethers (PBDEs) and Polychlorinated Biphenyl 153 (PCB) and Anthropometric Measures in Children**

Delphine Bosson-Rieutort

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**Abstract:** Background: The prevalence of overweight and obese children is rising but factors responsible for this problem are not clear, although nutrition and physical activity most likely play a role. In addition, some environmental chemicals are suspected to have 'obesogenic' effects through disruption of endocrine function, but the data is sparse. Objective: We aimed to examine the prospective association between prenatal exposure to several persistent environmental chemicals (i.e., PFASs, PBDEs, PCB) and anthropometric measures during childhood. Methods: We used data from the Maternal-Infant Research on Environmental Chemicals (MIREC) study, a pregnancy cohort recruited in 2008-2011 in Canada. Anthropometry was assessed at a median age of 3.3 y (standard deviation, 0.9 y), i.e. BMI and skin-fold thickness of the arm and back (n=757). PBDEs, PFASs and PCB were measured in first trimester maternal plasma. We used multiple regression analysis to assess the confounders-adjusted relation between maternal contaminant levels and anthropometric measures standardized for age and sex. Results: In the study, 31.9% of children were classified as overweight or obese based on WHO child growth standards. Maternal BPC 153 concentration was associated with higher child BMI (for a doubling in concentration  $\beta = 0.04$ , 95% CIs: 0.01, 0.06), greater skin-fold thickness of the arm ( $\beta = 0.17$ , 95% CIs: 0.12, 0.21) and back ( $\beta = 0.06$ , 95% CIs: 0.04, 0.09). PBDE 47 and 153 were associated with higher arm skin-fold thickness ( $\beta = 0.16$ , 95% CIs: 0.08, 0.24 and  $\beta = 0.17$ , 95% CIs: 0.12, 0.21, respectively). On the other hand, higher maternal levels of PFOS was associated with decreased BMI ( $\beta = -0.17$ , 95% CIs: -0.30, -0.04); the odds for being overweight or obese were 0.61 (95% CI: 0.15, 0.83) for a doubling in PFOS concentration. Conclusion: Prenatal exposure to some PBDEs and PCBs may be associated with an increasing adiposity in childhood, whereas we found suggestion of inverse relation with PFOA.

**P03.2600. Surveillance of Arsenic and Lead Exposure in Mother-Child Pair from Arica, Chile 2013-2016**

Macarena Valdes

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**Abstract:** Introduction: During the 80 and 90's, the polymetallic rubbish derived from Sweden and the transportation of minerals between Chile and Bolivia, exposed many urban zones in Arica, Chile. It was needed to implement a surveillance of polymetallic exposure in the population. The aim of this study was to describe the concentrations of arsenic in pregnant women and lead in the umbilical cord blood of newborns included in the surveillance of polymetallic exposure of the births occurred between 2013 and 2016 in Arica, Chile. Method: Cross-sectional design. 1676 mothers and 1706 children attended in public health facilities and whose birth occurred between 2013 and 2016 was characterized using a standard questionnaire implemented in the surveillance of arsenic and lead exposure. A sample of urine was taken from mothers in order to measure inorganic arsenic (As-I), and an umbilical cord blood sample was taken during the birth to determine lead concentration. Sociodemographic data were obtained from the surveillance survey. The univariate and bivariate analyses were used to describe both pollutants in the mother-child pair. Multiple logistic regression was done to explore the association between an arsenic concentration above 35mg/L and risk factors. Results: The median of urinary As-I was 15 mg/L (Min-Max: 2.5-127); the proportion of urinary As-I above 35 mg/L was 7.4%, and the risk factors related to this were shellfish consumption and street paving. The median of lead was 0.5 mg/dL (Min-Max: 0.5-6). The lead concentration above 5 mg/dL was less than 1%, and none of the risk factors included in this analysis was significantly associated. Conclusion: The arsenic concentration showed a wide variability; it might suggest different sources of exposure such as shellfish consumption and street paving. Given the low lead concentrations and scarce variability of the data, surveillance is suggested only in subsamples of the population.

### **P03.2610. Gestational Urinary Bpa Concentrations and Child Adiposity at Age 3 Years: The MIREC Study**

Joseph Braun

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**Abstract:** Background: Bisphenol A (BPA) is a high production volume chemical, and because of its use in numerous consumer products, exposure is ubiquitous. Prenatal BPA exposure has been associated with excess adiposity in rodent studies, but not consistently in human studies. Objectives: We investigated the relation between prenatal BPA exposure and early childhood adiposity in a prospective cohort study of 686 mother-child pairs. Methods: We used data from the Maternal Infant Research on Environmental Chemicals (MIREC) Study, a prospective pan-Canadian pregnancy and birth cohort study. We measured BPA in urine samples collected at an average of 13 weeks gestation. In six of the cities, we measured children's weight, height, waist/hip circumference, and subscapular/triceps skinfold at an average of age 3.4 years. Using linear regression, we estimated covariate-adjusted associations between log<sub>2</sub>-transformed urinary BPA concentrations and adiposity measures. Results: Median urinary BPA concentrations were 0.8 ng/mL (IQR: 0.5-1.4). Among all children, there was no association between BPA and child adiposity. However, the association of BPA with waist circumference and subscapular skinfold thickness was modified by child sex (sex x BPA interaction p-values<0.2). Among girls, each 2-fold increase in urinary BPA concentrations was associated with a 0.3 cm (95% CI: 0, 0.5) and 0.2 mm (95% CI: 0, 0.3) increase in waist circumference and subscapular skinfold thickness, respectively. Among boys, BPA was weakly inversely associated with subscapular skinfold thickness (b: -0.1; 95% CI: -0.3, 0.1), but was not associated with waist circumference (b: 0.03; 95% CI: -0.19, 0.25). Conclusions: In this cohort, prenatal urinary BPA concentrations were associated with subtle increases in measures of central adiposity during early childhood among girls, but not boys. Future studies should confirm these associations and determine if they persist into later childhood.

### **P03.2620. Exposure to Polybrominated Diphenyl Ethers (PBDEs) during Childhood and Adiposity Measures at Age 8 Years**

Ann Vuong

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**Abstract:** Background: Polybrominated diphenyl ethers (PBDEs) have been reported to be obesogens in laboratory studies. Only a few epidemiologic studies have investigated childhood PBDEs and adiposity; most reported an inverse association. Methods: We examined longitudinal data of 187 children in the Health Outcomes and Measures of the Environment Study, a pregnancy and birth cohort enrolled in Cincinnati, OH (2003-2006). We measured serum PBDEs (BDEs-28, -47, -99, -100, and -153) at ages 1, 2, 3, 5 and 8 years; multiple imputation was used to estimate missing PBDE concentrations, mostly at younger ages. At age 8 years, we assessed weight and body mass index (BMI) z-scores, waist circumference, and bioelectrical impedance based body fat percentage. To account for repeated PBDEs and to test for potential windows of susceptibility, we used multiple informant models to estimate covariate-adjusted age-specific associations between childhood PBDEs and adiposity measures. Results: We observe significant inverse associations between BDE-153 concentrations at ages 5 and 8 years and weight and BMI z-scores. A 10-fold increase in BDE-153 at ages 3, 5, and 8 was significantly associated with lower body fat (~2-4%). Ten-fold increases in BDE-153 at ages 5 and 8 years were significantly associated with decrements in waist circumference ( $\beta$ =-3.0 cm, 95% CI -5.4, -0.6;  $\beta$ =-5.4 cm, 95% CI -7.8, -2.9, respectively). No statistically significant associations were found between BDE-28, -47, -99, or -100 and measures of adiposity. Effect measure modification by child sex was noted, with significant decrements in body fat percentage observed in males ( $\beta$ =-2.8, 95% CI -5.1, -0.4) with higher concurrent BDE-153, but close to a null association in females ( $\beta$ =0.2, 95% CI -5.1, 5.6). Conclusions: Childhood BDE-153 concentrations were inversely associated with weight and BMI z-scores, body fat percentage, and waist circumference. We cannot rule out reverse causality due to PBDEs' lipophilic nature.

### **P03.2630. Early-Life Triclosan Exposure and Behavior Problems in 8-Year-Old Children**

Medina Jackson-Browne

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**Abstract:** Background: Triclosan may decrease circulating thyroxine levels or interfere with thyroid hormone signaling to adversely affect neurodevelopment. However, we are unaware of studies examining associations between triclosan exposure and childhood behavior problems. Methods: We used data from mother-child pairs enrolled in a Cincinnati, OH pregnancy and birth cohort study between 2003-2006 (The HOME Study). In 202 mother-child pairs, we quantified urinary triclosan concentrations in up to 3 maternal samples collected between 2nd trimester of the pregnancy and delivery, and in up to 6 child samples between ages 1 and 8 years. Caregivers rated their children's behavior at age 8 years using the Behavioral Assessment System for Children-2. We used a two-stage model to estimate changes in behavior problem scores with a 10-fold increase in mean gestational or childhood triclosan concentrations, accounting for triclosan exposure measurement error. Results: Gestational triclosan was positively associated with externalizing problem scores and some related clinical subscales; these associations were stronger in boys than girls (triclosan x sex interaction p-values < 0.2). Specifically, each 10-fold increase in gestational triclosan was associated with higher externalizing ( $\beta$ : 5.0; 95% CI: 1.1-8.9), attention ( $\beta$ : 6.4; 95% CI: 2.2-11), and hyperactivity ( $\beta$ : 6.4; 95% CI: 2.2-11) scores in boys. We observed a similar pattern of associations of childhood triclosan with externalizing and related clinical subscales, but these associations were substantially attenuated after we adjusted for gestational triclosan. In contrast, associations between gestational triclosan and behavior problems were slightly attenuated. In general, triclosan concentrations were not associated with internalizing problems. Conclusion: In this cohort, gestational urinary triclosan concentrations were associated with more externalizing, inattention, and hyperactivity behaviors at age 8 years in boys, but not girls.

**P03.2640. An mHealth Platform for Predicting Risk of Pediatric Asthma Exacerbation Using Personal Sensor Monitoring Systems: The Los Angeles Prisms Center**

Rima Habre

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**Abstract:** Pediatric asthma is a complex and heterogeneous chronic disease that affects millions worldwide and results in significant morbidity and mortality. Studies have shown environmental exposures such as air pollution to be associated with risk of asthma attacks, but little is known about the time lag between exposure and response, the role of multiple exposures in context, and variation in personal risk at short temporal and fine spatial scales. As part of the Los Angeles PRISMS Center, the LA PRISMS Breathe (Biomedical Real-Time Health Evaluation) Kit is being developed as a non-invasive, secure end-to-end informatics platform that utilizes the latest in mHealth technologies to advance environmental health studies of pediatric asthma. The platform is based on a smartwatch/smartphone that securely and wirelessly communicates with a suite of personal environmental, physiological and health sensors in real time and collects self-report symptoms data and contextual information using Ecological Momentary Assessment methods. External environmental data such as meteorology, traffic and air quality is also collected based on time and location of the participant. Data is integrated and analyzed to build individualized exposure and asthma exacerbation prediction models and the information is fed back to asthmatics, caretakers and physicians to improve asthma management. This talk will present key components of the Breathe Kit and its deployment in environmental health research studies, including participant engagement, compliance and burden considerations. Data from preliminary pilot testing in a panel study of children with asthma recruited from the UCLA Pediatric Pulmonology clinic will be presented. The ultimate goal of the LA PRISMS Breathe Kit is to be able to predict a looming asthma attack in an individual so that early intervention methods can mitigate if not prevent the episode entirely.

### **P03.2650. Analysis of Perfluoroalkyl Substances in Deciduous Teeth**

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Abstract: Researchers continue to explore novel sources of biospecimens suitable for quantifying environmental toxins at the population level. Deciduous teeth have been used for decades to quantify exposure to heavy metals in children. The mineralization of primary teeth begins around mid-gestation and concludes at age 1 year. After this period, dentine undergoes very limited remodeling and thus preserves concentrations of environmental toxins. Whether deciduous teeth can be used as biospecimens to measure early exposure to organic chemicals remains unclear. We explored the feasibility and utility of such an approach using the Upstate KIDS Study (2008-2010, upstate New York). We previously quantified 2 perfluoroalkyl substances (PFASs) [perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate] in newborn dried blood spots (DBS) for participating children. We collected deciduous teeth from 64 children (38 singletons and 26 twins, 1 tooth per child). After pulverizing each tooth, samples were extracted by methyl-tert-butyl ether. The extracts were analyzed by liquid chromatography-tandem mass spectrometry to measure 13 PFASs. Limit of quantitation ranged from 0.2 ng/g for perfluorooctanesulfonamide to 1.85 ng/g for perfluorodecane sulfonate. PFOA was detectable in 10 (15% of 64) samples; perfluorononanoic acid and perfluoroheptanoic acid in 1 sample each. Other PFASs were not detected. The mean (SD) PFOA concentrations in 10 samples was 0.83 ng/g (0.39 ng/g) (median=0.65 ng/g; range=0.57-1.56 ng/g). Despite the low number detectable, the correlation of PFOA concentrations quantified in teeth and in DBS was  $r=0.76$ ,  $p=0.08$  ( $n=6$  with both measurements). Median PFOA concentrations, quantified in DBS, did not differ between the 38 children with no PFOA detected in tooth samples compared to 6 with detected PFOA [1.18 ng/ml, interquartile range (IQR)=1.02 vs. 0.97 ng/ml, IQR=0.62]. In conclusion, our results suggest that deciduous teeth underestimate children's exposure to PFASs.

**P03.2660. Bisphenol A in Different Compartments for Mother-Fetus Pairs in Taiwan and Health Effects of Newborns**

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Abstract: Bisphenol A (BPA) is found in many consumer products as it is used to produce polycarbonate plastics and epoxy resins. It is a well-known endocrine disruptor and has drawn great concern on the adverse effects on the growing fetus and neonates. The aims of this study were (1) to determine BPA levels in different compartment of mother-fetal pairs, (2) to investigate the correlation between birth outcomes and prenatal exposure to BPA, and (3) to evaluate the potential risk from exposure to BPA for the breast milk fed infants. We analyzed 65 mother-fetus pairs' maternal urines, placenta, cord blood, and 1st& 3rdmonth breast milk by UPLC/TOF-MS. A questionnaire was used to collect socio-demographic data and information about birth outcomes was obtained from medical records. The daily intake of BPA in breast milk was calculated using probabilistic risk assessment methods. The GM (GSD) of BPA levels in maternal urine, fetal cord blood, placenta, first and three month breast milk were 2.08 (3.18)  $\mu\text{g/g}$  creatinine, 3.73(2.40)ng/mL, 3.39(2.13)ng/g, 1.35(3.59) and 2.90(2.85)ng/g, respectively. There are no significant associations between pregnant women urine, fetal cord blood and placental BPA levels and birth outcomes in this study. Three percent of one-month-old babies and one percent of three-month-old babies exceeded 4  $\mu\text{g/kg-bw/day}$ , proposed as temporary TDI by the European Food Safety Authority. In conclusion, this study provides the exposure profile and distribution of BPA in different compartments among mother-fetus pairs in Taiwan. Only few infants were exposed to BPA levels exceeding the temporary TDI BPA.

## **P03.2670. The New York University Children's Environmental Health Study (NYU CHES): Design and Objectives**

Linda Kahn

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**Abstract:** The New York University Children's Environmental Health Study (NYU CHES) is an NIH ECHO-funded birth cohort designed to assess the impact of prenatal exposure to environmental chemicals on pregnancy, child, and postnatal maternal health. Since March 2016, NYU CHES has enrolled women from 3 NYU-affiliated hospitals at <18 weeks gestation. Participants provide biosamples and questionnaire data in all 3 trimesters and at birth. Cord blood and placental samples are collected at delivery. Participants complete online surveys or phone interviews at child ages 4 and 8 months. At 12 months, mothers and children undergo physical assessments and body composition analyses, children provide urine and stool samples and are screened for developmental delays, and mothers provide urine samples and undergo tests of cardiovascular function. Future contacts will occur at 18 months (online/phone) and 2 years (in person). As of 3/28/18, 1347 women have enrolled of whom 696 (52%) have delivered, 7% have experienced pregnancy loss or termination, and 5% have been lost to follow-up. Participants are mean age 31.8 years (SD 5.8). Half (49%) self-identify as Hispanic, 33% as White, 6% as Black, and 8% as Asian. Two-thirds are employed (64%), have at least some college education (65%), and have annual household income  $\geq$ \$50,000 (65%). Among women who have delivered, 523 (75%) have consented to postnatal follow-up and 11% are in the process of being recruited. Among offspring, 8% were preterm (<37 weeks) and 7% were low birth weight (<2500 g). Prenatal recruitment continues at an average of 17 new participants per week. Prenatal urine samples are currently being assessed for non-persistent chemicals (bisphenols and metabolites of phthalates, organophosphates, and polycyclic aromatic hydrocarbons). Initial analyses will examine associations among maternal chemical exposure, cytokine levels, thyroid function, blood pressure, gestational weight gain, fetal growth, and birth outcomes.

### **P03.2680. Urinary Trace Metals Individually and in Mixtures in Association with Preterm Birth**

Stephani Kim

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Abstract: Preterm birth (PTB), birth <37 weeks gestation, affects 1 in 10 births in the United States. Though some risk factors have been identified, most causes remain unknown. Exposure to high levels of metals has been linked to higher risk of PTB, but consequences of lower levels of exposure, less studied metals, and combinations of these factors are unclear. In collaboration with the Children's Health Exposure Analysis Resource, we examined the association between 17 urinary trace metals and PTB. The LIFECODES birth cohort enrolled pregnant women at <15 weeks gestation at Brigham and Women's Hospital in Boston. Women participated in 4 study visits. We selected cases of PTB (n=99) and unmatched controls (n=291) and analyzed urine samples from visit 3 (median: 26 weeks) using mass spectrometry. We used logistic regression models to calculate odds ratios (OR) for PTB, controlling for maternal age, race, education, pre-pregnancy body mass index (BMI), specific gravity, and gestational age at time of urine collection. We used elastic net (ENET) regularization methods to determine which metals were driving the association with PTB and whether there were any meaningful interactions between exposures. We observed increased odds of PTB (OR: 1.88, 95% CI: 1.24, 2.86) associated with an interquartile range difference of copper (Cu). We also observed an elevated OR for selenium (OR: 1.92, 95% CI 0.95, 3.87). In addition, we observed small differences in associations with individual metals by presentation of PTB. The ENET methods selected Cu as the primary driver in the association with PTB. ENET also selected interactions between Cu and several other metals, including cadmium, molybdenum, selenium, and zinc. Our results suggested that Cu concentration in mothers at the 3rd trimester was associated with increased risk of PTB, despite Cu being an essential nutrient.

### **P03.2700. Measures of Maternal Psycho-Social Stress and Biomarkers of Stress Response in the Maternal-Fetal Unit**

Rachel Morello-Frosch

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**Abstract:** In a cohort of 500 pregnant women recruited from two San Francisco hospitals serving economically and ethnically diverse populations, we used Targeted Minimum Loss-Based Estimation (TMLE) to evaluate the association between perceptual measures of maternal psycho-social stress and two biological measures of stress response: 1) telomere length (TL) in umbilical cord blood leukocytes collected at delivery, and 2) corticotropin-releasing hormone (CRH) in maternal plasma collected during the 2nd trimester. We evaluated ten dimensions of maternal stress, derived from questionnaires: job-related, neighborhood, community standing, experience of racism, perceived stress, acute stressful events, depression, pregnancy satisfaction, nativity, and material deprivation. All domains were identified as important predictors of TL/CRH in non-parametric variable important analyses. Therefore, CRH analyses included all stressors and were adjusted for pregnancy complications, mother's age, parity, and race/ethnicity. TL analyses were additionally adjusted for infant sex, and gestational age at birth. 30% of participants identified as Latina, 7% Black, 40% White, 16% Asian, and 7% identified as other/mixed. Less than 10% of women did not complete high-school and 60% had a bachelor's degree or higher. Biologic factors were more important at predicting TL than stress. Conversely, stress was more important at predicting CRH than biological factors. Counter-intuitively, experiencing racism (0.15, 95% CI: 0.12-0.17) and perceived stress (0.24, 95% CI: 0.21-0.27) were associated with greater TL (expressed as the relative ratio of telomere repeat copy number to single-copy gene copy number or T/S ratio). Pregnancy complications were associated with elevated CRH (0.13, 95% CI: -0.02-0.28), while pregnancy dissatisfaction was associated with lower CRH (-0.15, 95% CI: -0.30-0.01). Results suggest complex relationships between perceived stress and response biomarkers in the maternal-fetal unit.

### **P03.2710. The Effects of Maternal Cadmium Exposure and Attention Deficit Hyperactivity Disorder in Children 6 Years of Age**

Woo Sung Kim

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**Abstract:** BACKGROUND: Prenatal environmental cadmium exposure in children may be associated with attention deficit hyperactivity disorder (ADHD) in children. OBJECTIVE: To examine the relationship between the heavy metal cadmium exposure during gestation and child ADHD at 6 years of age. METHODS: As part of an on-going cohort named "The Environment and Development of Children", 203 mother-child pairs from Seoul, Korea were enrolled between 2008 and 2011. Whole blood concentration of cadmium was analyzed. Multivariable linear regression models were used to investigate the relationship between exposure to cadmium with ADHD. RESULTS: Prenatal cadmium concentrations were associated with increased scores for ADHD at 6 years of age. Each 2-fold increase in prenatal cadmium level was significantly associated with an 23.8% [95% confidence interval (CI): 13.2%, 35.4% ] increase in Attention Deficit Hyperactivity Disorder in 6 year old children, as indicated by the linear regression model. CONCLUSION: Our results identified associations between prenatal cadmium levels with ADHD at 6 years of age. This research was supported by a grant (18162MFDS121) from Ministry of Food and Drug Safety in 2018 and Center for Environmental Health through the Ministry of Environment.

**P03.2720. Hormonal Changes at Early Age and Prenatal Exposure to Phthalates and Bisphenol A in a Cohort of Cuernavaca, Morelos, Mexico**

Hernández Leticia

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Abstract: Has been suggested that phthalate and BPA A exposure in utero may impact hormone concentrations and evolve the onset of early puberty. The objective of this study was to evaluate the association between prenatal exposures to phthalates and hormonal levels at 9 years old in a Cuernavaca, Morelos birth cohort (POSGRAD study). In a subsample of 314 children, total testosterone hormone levels and dehydroepiandrosterone sulfate (DHEA-S) were measurements from serum samples at 9 years of age from both sex. These levels were contrasted with the concentrations of 9 different metabolites of phthalates [Mono-2-ethylhexyl phthalate (MEHP), Mono-2-ethyl-5-carboxypentyl phthalate (MECPP), Mono-2-ethyl-5-hydroxyethyl phthalate (MEHHP), Mono-2-ethyl-5-oxohexyl phthalate (MEOHP), Mono-3-carboxypropyl phthalate (MCPP), Monobenzyl phthalate (MBzP), Monobutyl phthalate (MBP), Mono-iso-butyl phthalate (MiBP) and Mono ethyl phthalate (MEP)], and Bisphenol A in urine resulting from samples of mothers during the second trimester of pregnancy, through a multiple linear regression model adjusted for anthropometric variables of the child and sociodemographic characteristics. RESULTS. A significant relationship was observed with the LnMECPP and LnMEHHP with total testosterone levels, (increase of 13%, IC95%: 0.9%, 24%, and 11% increase, IC95% 0.16% to 23.6% en IU / L, by unit of increase in each metabolite, respectively. No metabolite showed a statistically significant association with DHEA-S levels, however, in girls who initiated menarche at 9 years old, significant association were observed with MiPB, MBzP and BPA with an increase of DHEA-S. DISCUSSION. Our results are consistent with previous studies in which it has been suggested that prenatal exposure can to induce can lead to early puberty. In our case, the exposure window was during the second trimester suggesting more prevention in this stage of life.

**P03.2730. Urinary 3-Phenoxybenzoic Acid Concentrations In Utero and in Childhood: Association with BMI Z-Score in 4-Year-Old Children**

Kyung-Shin Lee

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**Abstract:** Background Pyrethroids, a class of ubiquitous insecticides, have been considered as endocrine-disrupting chemicals. The use of pesticides has increased over the past few decades, which raise concerns on possibility of health effects, particularly in children. However, only a few studies have been conducted to examine the relationship between 3-phenoxybenzoic acid (3-PBA) and children's health effects. Because exposure to 3-PBA may affect children's growth, we aimed to evaluate the association between prenatal and postnatal 3-PBA concentrations and body mass index in 4-year-old Korean children. Method We used the data from 578 children (309 boys and 269 girls; 45-55 months) at 4 years of age who were born from women who participated in the Environmental and Development in Children (EDC) cohort study from August 2008 to July 2011. Urinary 3-PBA concentration from mother at around 20 weeks of gestation and 4-year-old children was measured as prenatal and postnatal 3-PBA exposure, respectively. Result The geometric mean of BMI z-score of 4-year-old children was 1.308 and 95 percentile of BMI z-score was 1.389. Urinary 3-PBA was detected in 98.9-99.8% of prenatal and postnatal urine samples. The relationship between 3-PBA exposure at 4-year-old and BMI z-score of 4-year-old children was positively significant (p-value=0.0426). After sex stratification, the association remained significant among girls (p-value=0.0041), but not among boys. However, there is no association between prenatal 3-PBA exposure and BMI z-score at 4 years of age (p-value=0.6210). Conclusion Childhood adiposity measured as BMI Z-score was associated with urinary 3-PBA concentrations in children at 4 years of age. Keywords Pyrethroid, 3-phenoxybenzoic acid, BMI Z-score, children Funding's This research was supported by a grant (18162MFDS121) from Ministry of Food and Drug Safety in 2018 and Center for Environmental Health through the Ministry of Environment.

### **P03.2750. Phthalates Exposure Is Positively Associated with Increased Risk of Microalbumin in the General Taiwanese**

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**Abstract:** Background/Aim Phthalates (PAEs) are well-known endocrine disruptors and previous studies indicated that human exposed to phthalate-tainted products were positively associated with increased urinary microalbumin. We aim to assess the relationship between PAEs exposure and renal function index in the general Taiwanese. Methods We enrolled 311 subjects [ $\geq 40$ / $<40$  years old (yrs), N=183/128] who provided questionnaire, blood and urine samples from the Taiwan Environmental Survey for Toxicants (TESTs) 2013. Urinary PAEs metabolites were analysed by LC/MS-MS. We measured levels of serum blood urea nitrogen (BUN), and urinary creatinine, microalbumin, and protein. We calculated two renal function index, estimated glomerular filtration rate (eGFR) and microalbumin/creatinine ratio (ACR), in each subject. We used multiple and logistic regression or cumulative risk assessment (estimated HI values, HI<sub>hep</sub>) to evaluate the relationships between PAEs exposure and biomarkers or renal function index. Results Median (interquartile range) levels of urinary  $\Sigma$ DEHPm/ $\Sigma$ DBPm in subjects  $<40$  yrs were 0.29(0.17-0.44)/0.14(0.10-0.30)nmole/mL, which were higher than those  $\geq 40$  yrs ( $\Sigma$ DEHPm:0.19(0.12-0.32)/ $\Sigma$ DBPm:0.11(0.05-0.19) nmole/mL). Adjusted odds ratio of the highest quartile of estimated DEHP daily intake in subjects  $\geq 40$  yrs for abnormal microalbumin was 14.2 (95% confidence interval (CI)=1.52-133.3) fold higher than the lowest quartile group, whereas no risk was observed in subjects  $<40$  yrs. We found that cumulative HI<sub>hep</sub> were significantly increased with urinary microalbumin ( $\beta$ : 5.12, 95%CI:2.52- 7.72), ACR ( $\beta$ :1.12, 95%CI:0.005-2.23), and protein ( $\beta$ :3.05, 95%CI:0.94-5.12) in subjects  $\geq 40$  yrs after adjustment of age, sex, BMI, smoking, and drinking. Conclusions. Our findings suggested that high DEHP and cumulative PAEs exposure were significant positively associated with increased risk of urinary microalbumin. Large cohort and mechanistic studies are worthy to elucidate the associations.

**P03.2760. Variability of Urinary Phthalate Metabolite, Bisphenol, and Ultraviolet Filter Concentrations across Sensitive Windows of Human Reproduction**

Anna Pollack

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**Abstract:** Background: Pre-pregnancy and early pregnancy levels of phthalate, ultraviolet filter, and bisphenol exposure may be associated with adverse reproductive health endpoints. Characterizing variability across sensitive windows of human fecundity can assist in guiding epidemiologic study design of these exposures. In particular, no prior studies have characterized non-persistent endocrine disrupting chemicals across sensitive windows of human reproduction. Methods: We characterized the variability of 12 urinary phthalate metabolites, 6 bisphenol, and 5 ultraviolet filter concentrations prior to and during early pregnancy from 501 women with 1-4 samples per person collected from 2005-2009. Couples were recruited after discontinuing contraception prior to attempting a pregnancy and were followed daily until pregnant. The 343 (68%) women who became pregnant were followed daily through 7 weeks post-conception. We characterized chemical biomarker variability using intraclass correlation coefficients (ICCs) for women from the cohort overall, and by pregnancy status and race/ethnicity. Results: All ICCs (95% CIs) were <0.50 and varied by chemical class (in descending order): 0.46 (0.39, 0.52) for mEP, 0.36 (0.28, 0.43) for BP-1, 0.32 (0.24, 0.39) for BP-3, and 0.26 (0.18, 0.34) for mBP. Several phthalates and one benzophenone had lower reliability (ICC 0.20 to 0.29): mCPP, mBP, mibP, mCHP, mCMHP, and 4-OH-BP. All bisphenols measured were quite variable (ICC -0.11 to 0.01). We did not find substantial differences across ICCs when data were stratified by pregnancy status and race/ethnicity. Conclusion: The observed reliability was fair for monoethyl phthalate and poor for all others (ICC<0.4). A single measurement of non-persistent EDCs does not appear to reliably capture exposures over sensitive windows. To this end, longitudinal measurements are needed to ensure the validity of findings relative to these exposures and human fecundity and fertility.

### **P03.2770. Repeated Measures of Urinary Phthalates, Benzophenones and Bisphenol A in Relation to Incident Pregnancy Loss**

Anna Pollack

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**Abstract:** Background: Studies suggest nonpersistent endocrine disrupting chemicals such as phthalates, benzophenones and bisphenols may be associated with diminished fecundability, but little research has focused on their association with incident pregnancy loss. Methods: Using a prospective cohort design, 501 couples were recruited upon discontinuing contraception to try for pregnancy and followed daily until pregnant and through 7 weeks post-conception; 343 (68%) women with singleton pregnancies comprise the study cohort. Urine samples were collected upon enrollment (n=315; 92%), in the second (n=200), third (n=206), fourth (n=32) and sixth cycles (n=10). Bisphenols A, 5 benzophenones, and 13 phthalate metabolites were quantified using LC tandem MS. Generalized estimating equations estimated the relative risk (RR) of incident pregnancy loss for each chemical. Exposures were treated as continuous (log+1 transformed rescaled by standard deviation) and categorical (tertiles), adjusting for body mass index, race, serum cotinine, and age. Results: Incidence of pregnancy loss was 28% before 20 weeks' gestation. Lower risk of loss was noted for mOP (RR=0.69; 95% CI 0.54, 0.88), while mEHHP and mEOHP were suggestive of higher risk of loss. Relative to the first tertile, a higher risk of loss was observed for 2 benzophenones, for women in the second tertiles of BP-1 (RR=3.44; 95% CI 1.69, 7.01) and BP-3 (RR=2.02; 95% CI 1.02, 3.97), whereas a lower risk was observed for 4-OH-BP (RR=0.28; 95% CI 0.15, 0.53) and also for 2 phthalate metabolites: mCPP for 3rd vs. 1st (RR=0.35; 95% CI 0.13, 0.93) and mBP for 2nd vs. 1st (RR=0.45; 95% CI 0.23, 0.91). Conclusion: Benzophenones, as a class of chemicals, were suggestive of a possible association with pregnancy loss, and specifically BP- 1 and BP-3, which are believed to have estrogenic activity. Given their widespread use in personal care and sunscreen products and opposing pattern for 4-OH-BP, further investigation is needed.

### **P03.2780. Association between Radiofrequency Exposure during Pregnancy and Birth Outcomes in South Korea: Birth Cohort Study**

Yong-Han Lee

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**Abstract:** Introduction: It is controversial whether RF (radiofrequency) exposure during pregnancy is hazardous to fetus. The aim of the present study is to elucidate the association between maternal RF exposure during pregnancy and birth outcomes. Method: Data from Mothers and Children's Environmental Health (MOCEH), a multicenter prospective birth cohort study in South Korea, was used in the present analysis. In 2011-2014, a total of 1751 pregnant women were recruited for the cohort, and we measured RF exposures of 244 women randomly selected from the cohort. RF exposure was measured via personal exposure meter (EME-Spy100®) for 24 hours at enrollment within 20 weeks of pregnancy. Each woman's RF exposure was calculated as sum of square of arithmetic mean for all measured levels divided by guidance level of each frequency band, and we calculated sums for total RF and mobile phone RF. We divided the women into 4 groups according to quartiles of RF exposure. At birth, weight, height, and gestational age were recorded. We used multiple regression model to examine associations between RF exposure and birth outcomes. We considered potential confounding factors such as maternal age, parity, smoking, alcohol consumption, education, income, marital status, child's sex, and birth area. Result: Birth weight and height of highest quartile group of total RF (-258.1g [95% CI=-485.6, -30.6] and -2.4cm [-3.8, -1.1], respectively) and mobile phone RF (-284.6g [-513.3, -56.0] and -2.0cm [-3.2, -0.7], respectively) were lower than those of lowest quartile groups. The results from models adjusting for gestational age were similar. Mean gestational age of highest quartile group of total RF was shorter than that of lowest quartile group (-4.2day [-9.9, 1.5]). Conclusion: We observed significant adverse associations between RF exposure and birth outcomes.

### **P03.2790. Effects of Prenatal Exposure to Phthalates on Neonatal Birth Weight: SHK Birth Cohort**

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Abstract: Phthalates exposure were associated with lower birth weight. However, there's limited data on whether phthalates could affect birth weight directly or indirectly through gestational age and pregnancy syndrome. To evaluate the effects of prenatal exposure to phthalates on birth weight in neonates, 181 mother-newborn pairs were recruited from SHK birth cohort. Maternal urine samples were collected during the third trimester and measured for phthalate metabolites by the method of ESI-MS/MS. Structural equation models (SEM) were used to evaluate the direct effect of phthalate on birth weight controlling for maternal education, monthly income, nutritional supplements, infant gender and maternal weight gain per week. The potential indirect effects of phthalate exposure through gestational age on birth weight, as well as the potential indirect effect through pregnancy syndrome were also calculated by SEM method. After adjusting for all mediators, urinary phthalate levels were negatively associated with birth weight. An increasing ten-fold concentration of MEOHP and MEHHP would directly reduce birth weight in 124g and 107g, respectively. However, MBP had indirect effect on birth weight through gestational age, which caused an 85g reduction for every unit increase in log-transformed exposure. Both direct and indirect effects on birth weight were found in MMP and MEHP. The indirect effects of MMP and MEHP were mediated through gestational age and pregnancy syndrome. Totally, prenatal MMP and MEHP exposure were associated with 96g and 61g decreased birth weight, respectively. There's a negative association between prenatal phthalate exposure and birth weight in Chinese neonates. Besides direct pathway, phthalate exposures could affect birth weight through the mediating effects of gestational age and pregnancy syndrome.

### **P03.2800. Lactational Exposure to Phthalates: Preliminary Results from an Italian Cross-Sectional Study**

Elena Righi

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**Abstract:** Background: Human exposure to phthalates, endocrine disruptors and reproductive toxicants, is ubiquitous because of their extensive use as plasticizers. Breast milk is the optimal source of nutrition for newborns, however, it can be a source of exposure to several environmental contaminants, including phthalates. Up to date limited information exists on lactational exposure to phthalates and their metabolites in Italy: The aim of this study, therefore, was to determine the levels of 8 different phthalates diesters and monoesters in breast milk of women living in Modena, Italy, and to investigate the relationship with women's diet and other habits. Methods: 130 women (mean age: 33; range: 19 - 45 years) provided a sample of breast milk (30-40 days postpartum) and filled in a questionnaire on personal data and on potential sources exposure to phthalates. After solid extraction, samples were analysed by triple Quad LC/MS Mass Spectrometry. Results: Phthalate diesters, due to their metabolic degradation, resulted almost undetectable. Phthalate monoesters appeared more widespread. Among them, mono-isononylphthalate (MiNP) was detected in 125 breast samples (mean:  $1.63 \pm 2.71$ ; range: 0.10 - 18.4  $\mu\text{g/l}$ ) and mono-ethylphthalate (MEP) in 106 samples (mean:  $2.35 \pm 7.36$ ; range: 0.04 - 69.0  $\mu\text{g/l}$ ). Their levels appeared higher in lactating women more frequently using cosmetics or consuming food and beverages preserved in plastic containers. Differences, however, were not statistically significant. Further, levels appeared well below the daily intake levels established by the European Food Safety Authority (EFSA). Conclusions: Although a number of phthalate monoesters were detected in maternal breast milk, their concentrations tended to be lower than those reported in other international studies and the values recommend by EFSA. Human milk represent a unique nourishment for infants in a crucial period of their life: its use should not be discouraged.

### **P03.2810. Relationship of Trimester-Specific Gestational Exposure to High Molecular Weight Phthalates with Neurodevelopment at 48 Months and Differences by Sex**

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**Abstract:** In-utero phthalate exposure has been associated with neurodevelopmental disorders, further modified by child's sex. Pregnant women are ubiquitously exposed to high molecular weight phthalates (HMWP) through diet. Nevertheless, trimester-specific susceptibility to exposure and effect modification by sex remain understudied. Our aim was to identify susceptible windows to the effects of gestational HMWP exposure and effect modification by sex, on 48-months neurodevelopment. We measured six HMWP metabolites (MBzP, MEHP, MEHHP, MEOHP, MECPP and MCP) in urine samples collected during each trimester from women in the Early Life Exposure in Mexico to Environmental Toxicants (ELEMENT) cohort (n=218). We measured children's motor (MI) and cognitive (GCI) abilities using McCarthy Scales of Children's Abilities (MSCA, lower scores indicated poorer performance). We used linear regression models to examine associations between trimester specific phthalate metabolites (individual,  $\Sigma$ DEHP,  $\Sigma$ HMWP) and MI or GCI scores. Phthalates were log-transformed and specific gravity corrected for all analyses. Models were adjusted for sex, gestational age at birth, breastfeeding, and maternal IQ. Effect modification was assessed stratifying by sex. Phthalate concentrations were similar across trimesters. All 1st and 2nd trimester phthalates were negatively associated with MI and GCI scores, while half of the 3rd trimester phthalates showed positive associations. Associations between 1st trimester phthalates and MI scores were the strongest and statistically significant (e.g. MECPP  $\beta$  = -2.6, 95% CI (-4.4, -0.8)). For GCI scores, the magnitude of negative associations were similar for the 1st and 2nd trimester phthalates, but not statistically significant. Overall, boys had stronger GCI and MI negative associations than girls. Our results suggest that HMWP exposure specifically during early pregnancy were strongly associated with poorer motor abilities at 48 months, particularly in boys.

### **P03.2820. Risk Factors for Asthma Symptoms in Children: ELSPAC-CZ Study**

Ondrej Mikes

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Abstract: Asthma and asthma symptoms are increasingly prevalent in children worldwide. Wheezing and shortness of breath in the childhood are a heterogeneous condition, which may, in some cases, led to development of asthma. While the genetic predisposition is a clear risk factor for development of wheezing and or asthma, environmental factors could explain variation in prevalence rates. In this study, we temped to evaluated relevant protective and risk factors including socioeconomic determinants, indoor and outdoor environment, parental behaviour, diet, mode of childbirth and others. Where possible we have also studied the timing of the exposure. The Czech part of the European Longitudinal Study of Pregnancy and Childhood (ELSPAC-CZ) was established in the early nineties in the Czech Republic with recruitment of thousands of families and follow up until the 19 years of children, has been used to evaluate the factors. Multinomial logistic regression analysis with potential covariates was performed. We were able to determinate the risk factors for different phenotypes of childhood wheezing and shortness of breath.

### **P03.2830. Risk Factors for Childhood Asthma and Wheeze: Comparisons from an International Study**

Joshua Lawson

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**Abstract:** Background and objectives: International differences in childhood asthma prevalence have been reported with the environment suspected to play a role. We sought to investigate risk factors for asthma and wheeze and their consistency between countries. Methods: This was an international, cross-sectional study of children (6-13 years) living in an urban centre from Belarus, Canada, Republic of Georgia (Adjara), Republic of Macedonia, Poland, and Ukraine. History of physician-diagnosed asthma and wheeze in the past 12 months were ascertained from parent completed survey. Basic survey information was standardized but each site could include questions on additional potential risk factors. Multiple logistic regression was used to adjust for confounding. Results: In total, 12257 children participated (response rates: 26%-91%). Asthma prevalence was highest in Canada (12.6%) followed by Poland (10.3%) then the remaining sites (range: 1.0%-1.5%). Wheeze prevalence followed similar patterns but was higher than asthma (3.7% to 14.0%). In adjusted analyses using data from sites with the most comprehensive information (Canada, Poland, Macedonia), we found increased risk of asthma associated with antibiotic use, traditional medicine use, home mould or dampness, and family history of allergic conditions but a lower risk with being female ( $p < 0.05$ ). Similar results were seen when considering the outcome wheeze except that exposure to mice or pests increased the risk of wheeze and there was no association with home mould. There were some statistically significant interactions suggesting that the associations were not consistent between sites. Finally, when comparing no asthma or wheeze to those with wheeze without asthma as well as comparing no asthma or wheeze to those with asthma, risk factors were similar. Conclusions: Our findings suggest that in general, risk factors for asthma or wheeze are similar to what we expect but that some of these may be specific to certain locations.

### **P03.2840. Attention Deficit/Hyperactivity Disorder and Urinary Triclosan Levels in Children**

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**Abstract:** Background: Attention Deficit/Hyperactivity Disorder (ADHD) on This study investigated the associations (i) between triclosan exposure and ADHD in children; and (ii) gender-based differences. Methods: A total of 453 children from the Childhood Environment and Allergic diseases Study (CEAS) cohort with urine samples were recruited. Urine triclosan levels were measured by UPLC-MS/MS and markers of oxidative stress (8-OHdG) were measured by ELISA at the age 3 and 6. Information on serum 8-OHdG levels and the development of ADHD was collected. The association between triclosan levels at different stages and (8-OHdG) levels, and ADHD were evaluated by multivariate linear regression and logistic regression after adjusting for potential confounders . The triclosan levels at age 3 were higher than those at age 6 (geometric mean 1.05 vs 0.37 ng/mL). Triclosan levels at age 3 positively correlated with serum 8-OHdG levels at age 3 and 6. Triclosan levels positively correlated with ADHD (per ln-unit:  $\beta=0.867$  KU/l (95%CI: 0.534-1.409)) Triclosan levels positively correlated with autism and developmental delay (per ln-unit:  $\beta=1.227$  KU/l (95%CI: 0.829-1.816); per ln-unit:  $\beta=1.028$  KU/l(95%CI: 0.777-1.362)), although this was not statistically significant. Conclusion: Triclosan levels might positively correlate with ADHD, autism, and developmental delay, though failed to reach statistically significance.

### **P03.2850. Childhood Nutrient Mixtures and Neurodevelopmental Outcomes among Children in Mexico City**

Ashley Malin

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**Abstract:** Background: Adequate levels of beneficial nutrients are important for neurodevelopment. Although, nutrients are ingested in combination, considering nutrients as a mixture has not been studied with respect to health. Objective: To examine the impact of childhood nutrient mixtures on neurodevelopment. Methods: Participants included children in the Programming Research in Obesity, Growth Environment and Social Stress (PROGRESS) prospective birth cohort in Mexico City. We assessed child nutrition profiles among 329 children respectively by analyzing components of a food frequency questionnaire. Child neurodevelopmental outcomes at 4-6 years of age were measured using the McCarthy Scales of Children's Abilities (MSCA). Results: We conducted Weighted Quantile Sum regression analyses to calculate indices reflecting "good" and "poor" childhood nutrient mixtures. After adjusting for maternal education, socioeconomic status, the Home Observation for Measurement of the Environment score at 24-months postpartum and total caloric intake, the poor nutrition index significantly predicted lower scores on memory, quantitative and perceptual MSCA scales (Perceptual B = -1.88, at 95% CI = -3.17, -0.58), while the good nutrition index predicted higher scores on the perceptual scale (Perceptual B = 0.81, at 95% CI = 0.01, 1.61). In the poor nutrition index, higher sodium and saturated fat consumption and lower monounsaturated fat and protein consumption had relatively high weights when predicting poorer scores on various MSCA scales. In the good nutrition index, higher monounsaturated fat and calcium had relatively high weights within the mixture when predicting more favorable perceptual performance. Conclusions: Using a novel statistical method we found that childhood consumption of a mixture of beneficial nutrients had favorable effects on neurodevelopment. Furthermore, certain nutrients appeared to be more important for the development of certain skills and abilities than others were.

### **P03.2860. Proximity to Floricultural Production and Childhood Neuropsychological Function**

Marnie Hazlehurst

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**Abstract:** Background: Pesticide exposure during early childhood may be a risk factor for a range of pediatric neurologic deficits. Chronic exposure to these pesticides among children can occur due to drift from or direct contact with pesticide-treated areas. Methods: We examined 4-9 year-old participants who lived in agricultural communities in Ecuador (The ESPINA study). Two exposures were calculated: residential distance from the nearest flower plantation perimeter and total area of flower plantations within 200m of the home. Five neurodevelopment domains were assessed (NEPSY-2): Attention/inhibitory control, memory/learning, language, sensorimotor, and visuospatial processing. Linear and logistic regression models were adjusted for child's age, sex, race, height-for-age z-score, hemoglobin, mother's education, and cohabitation with a floricultural worker. Results: The 307 children in this study (mean age 6.6 years, 51% boys) lived on average 446m (SD 344) from a flower plantation. Mean (SD) neurobehavioral domain scores ranged from 6.6 (2.4) to 9.9 (3.3). For a 100m increase in distance between homes and plantations, there was better performance in the language domain by 0.09 units (95% CI: 0.00, 0.17). Children living within 185m of a plantation (quartile 1) had increased odds of clinically significant "low" scores in the language (OR [95% CI]: 2.4 [1.1, 5.5]) and memory/learning (4.8 [1.3, 19.0]) domains compared to children living >610m (quartile 4) from treated areas. Children with >3061m<sup>2</sup> (tertile 3 of non-zero values) of plantation area within 200m of their homes, compared to those with 0m<sup>2</sup> of plantation area, had increased odds for low memory/learning scores (4.3 [1.30, 14.1]). Conclusions: Residential proximity to floriculture plantations was associated with adverse neuropsychological performance in the domains of language and memory/learning among children, highlighting the importance of reducing pesticide exposures for children living near plantations.

### **P03.2870. Verbal and Learning Memory in Schoolchildren Exposed to Manganese in Mexico**

Horacio Riojas Rodriguez

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**Abstract:** Manganese (Mn) is an essential nutrient for cellular function, however, in high concentrations is neurotoxic. The inhalatory via is the most faster to transfer Mn to brain. Mn affects the development and function to the basal ganglia and frontal lobes. Environmental exposure to Mn has been associated with cognitive effects in children. Mexico has one the ten largest Mn deposit in the world. located northwest of state of Hidalgo. The aim to this study was asses the effect of environmental exposure to Mn on verbal memory and learning in schoolchildren from 7 to 11 years old residents of this area. Two cross sectional study were conducted (2006 and 2013). 268 schoolchildren were included, 146 children from the mining area and 122 from the non-mining area. The CAVLT-2 was used to assess verbal memory and learning. In addition, hair Mn levels (MnH) were determined using atomic absorption spectrophotometry. Linear regression models were constructed to estimate the association between MnH levels and CAVLT-2 scores, the models were adjusted by lead, hemoglobin, children age and sex, and maternal IQ. Children in the mining area on average had higher concentrations of MnH (5.12 µg/g) compared to schoolchildren in the non-mining area (0.56 µg/g). CAVLT-2 scores were significantly higher in children in the non-mining area compared to schoolchildren in the mining area. The levels of MnH were associated with a significant decrease in the scores of the trials 1 - 5 of the learning curve, level of learning, interference trial, immediate recall, delayed recall, immediate memory span and recognition accuracy. The main finding of this study was the negative association between MnH levels and verbal short- and long-term memory and learning abilities in schoolchildren exposure to Mn.

**P03.2880. Associations of Acetylcholinesterase Activity with Depression and Anxiety Symptoms among Adolescents Growing Up near Pesticide Spray Sites**

Jose Suarez-Lopez

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**Abstract:** Background: Self-reports of pesticide exposures have been associated with increased depression and anxiety symptoms among adult agricultural workers; research among children and adolescents is lacking and no studies have described these associations using biomarkers of exposure. Methods: We estimated the associations among 516 adolescents (ages 12-19y) in 2016 living in floricultural communities in Ecuador: The ESPINA study. Children's acetylcholinesterase (AChE) activity (lower values reflect greater organophosphate or carbamate pesticide exposure) was measured in a finger-stick sample. Anxiety and depression symptoms were assessed using the CDI-2 and MASC-2 (greater t-scores reflect greater internalizing symptoms). Models adjusted for age, gender, hemoglobin and anthropometric measures. Results: 51% of participants were female; the median age was 14.4y. The mean (SD) of the following parameters were: AChE 3.7 U/mL (0.55), depression t-score 53.0 (9.4) and anxiety t-score: 57.6 (9.8). AChE activity was inversely related to depression score (difference per SD decrease of AChE [ $\beta$ ]: 0.87 units [95%CI: -0.18, 1.91]); the OR for moderately elevated depression score (>55) per SD decrease of AChE was 1.28 [1.00, 1.62]. The association was stronger among children <14.4y ( $\beta$ : 2.00 units [0.22, 3.78]; OR: 1.41 [1.02, 1.96]) than among older adolescents ( $\beta$ : 0.28 units [-1.03, 1.60], OR: 1.17 [0.85, 1.62]). These associations were strengthened after accounting for 2008 AChE values. Among children <14.4y, the associations were stronger in girls (OR: 1.91 [1.00, 3.65]) than boys (OR: 0.90 [0.40, 2.03]). No associations were observed with anxiety scores. Discussion: This is the first study to describe associations between a biomarker of pesticide exposure and depression symptoms, in one of the largest studies of its kind. Cholinesterase inhibition may affect the mood towards depression of non-agricultural-worker adolescents, particularly among girls during early adolescence.

### P03. Adult Health Effects of Environmental Exposures 3

#### **P03.2890. Investigation of Spatial Clusters of Chronic Cardiopulmonary Diseases in New York City**

Bian Liu

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**Abstract:** We aim to identify localized spatial clusters for four common cardiopulmonary diseases: Asthma, chronic obstructive pulmonary disease (COPD), coronary heart disease (CHD), and stroke in New York City (NYC). We used the 500 Cities data from the Centers for Disease Control and Prevention, which provide prevalence estimates for chronic diseases, health behavioral and prevention measures at the census tract level for the 500 largest cities in the United States. Our analyses focused on NYC (n=2101 tracts) with additional sociodemographic data from the Census and pollution data from the Environmental Protection Agency. We first conducted a normal scan statistic (SatScan V9.5) using the crude prevalence with a weight adjustment based on the standard error of the prevalence. We also conducted a multivariate regression model using the four health outcomes as the dependent variables, with covariates being sociodemographic, unhealthy behavior and health care access, and pollution factors. Residuals from the model were used in SatScan for spatial cluster detection. Using the crude prevalence, we identified 3 and 2 high risk clusters for asthma and COPD, respectively. Using residuals, we found different cluster patterns. Comparisons of cluster locations and sizes showed a high residual risk cluster centered at 40.82N/73.96W with a 3.50-km radius (~ 100 tracts) in the west Harlem neighborhood for COPD, CHD, and stroke. The high residual cluster for asthma was centered at 40.64N/73.92W with an 11.54-km radius (n=1044 tracts), covering mostly Brooklyn and parts of Queens neighborhoods. The asthma cluster also overlapped with two small high risk clusters (<10 tracts) for COPD and stroke. Geographic variations of high and low risk clusters for chronic cardiopulmonary diseases exist in NYC even after adjusting for the usual suspected factors. The identified common clusters suggest intervention opportunities that may simultaneously benefit multiple chronic disease health outcomes.

**P03.2900. Exploring the Utility of World Trade Center Health Program Monitoring Data for Cancer Risk Factor Analysis: Preliminary Findings for Head and Neck Cancer**

Taylor Black

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**Abstract:** Purpose: Excess cancer has been reported among populations exposed to the 9/11 World Trade Center (WTC) attacks. This study explores the utility of the WTC Health Program (WTC-HP) General Responder (GR) monitoring data for analysis of head and neck cancer (HNC) risk factors. Methods: The WTC-HP provides medical monitoring and treatment for eligible WTC workers and volunteers. Monitoring visits include surveys about health and related exposures. Data from consenting participants are managed by the GR Data Center. We used a nested case-control design. HNC cases were selected using ICO-3 coding. Controls (8:1) were selected by risk-set sampling based on case diagnosis age and date, then matched within risk sets on sex and race/ethnicity. Distribution of WTC exposure, occupational groups prior to 9/11 (law enforcement(LE), construction, other), alcohol consumption (mod/heavy/former heavy vs. non-/occasional drinkers), and smoking status at first visit was assessed using conditional logistic regression. Results: In this preliminary analysis (65 cases; 555 controls), positive associations were observed between HNC and heavier alcohol use (OR=1.7; 95% CI: 0.9, 3.2) and occupation in law enforcement (OR LE vs. other = 1.9, 95% CI: 0.95, 3.8). BMI (body mass index) was significantly inversely associated with HNC (OR obese vs. normal =0.3, 95% CI: 0.1, 0.7). The distribution of WTC exposure and smoking status was similar among cases and controls. Finally, cases enrolled in the WTC-HP before and after their HNC diagnosis did not differ in respect to any of the risk factors considered. Conclusions: The weak associations with HNC were surprising and may indicate: risk factor misclassification or underreporting; unmeasured causal risk factor(s) (e.g. HPV infection); or inadequate power. Future analyses will include additional cases and refined risk factor assessments to examine the value of WTC-HP data for epidemiologic analyses of tobacco- and alcohol-related cancers.

### **P03.2910. An Underground Layer of Friable Asbestos in a Small Municipality in Colombia: Another Asbestos Contaminated Town?**

María Cely-García

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**Abstract:** Introduction: Sibate is a small town (38,000 inhabitants) nearby Colombia's capital, Bogotá. A water reservoir, el Muña, is located south-west of the town. Residents from Sibate report that during the 1970s and 1980s, parcels were filled with asbestos containing materials (ACM), to push out the heavily polluted waters of the reservoir from the urban area and create new land for urban development. Aims: The aims of this study are to confirm the existence of the landfills, and determine the presence of ACM in the soils of the town. Methods: Satellite images and topographic maps from different years were combined within a geographic information system to identify changes in height that could determine areas where lands were possibly filled. In some of these areas, soil samples were collected and analyzed by PLM following ASTM D7521-16 method and EPA' soil screening guidelines. Results: Ten potential landfill zones were identified, with a total area of approximately 30,000 m<sup>2</sup>. In three of these zones, four soil perforations were made. A grey layer of friable asbestos was found in 3 of the 4 perforations at different depths (35-110cm). All six samples of the grey layer of friable asbestos analyzed had a chrysotile content ranging between 5 to 10%, and one sample had 2% crocidolite. Non-friable asbestos materials were also analyzed, and asbestos content ranged between 2-10% for chrysotile, and one sample had 2% crocidolite. Current land uses of these zones include two soccer fields, an athletic track, and a school. Discussion: An important potential source of asbestos exposure has been confirmed in the town. This is a public health problem with potential and concerning implications. Further work will be conducted to determine the boundaries and characteristics of the landfills, as well as the risk of asbestos exposure at the surface. The health authorities of the municipality have been informed about the findings, and are currently working in a risk management strategy.

**P03.2920. Exploratory Descriptive Analysis: Incidence of Neoplasia and Congenital Malformations in Tremembe City - Sao Paulo - Brazil (1998-2017)**

Paulo Paz de Lima

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Abstract: The municipality of Tremembé is located in the Paraíba Valley region, in the State of São Paulo- Brazil. It has a population of 40,984 inhabitants. It houses an agricultural production mainly represented by the cultivation of rice by flooding technique and a chemical additives factory. The present study aims to analyze the incidence of neoplasms and congenital malformations in the city of Tremembé / SP; to analyze the health data of the municipality of Tremembé, referring to the neoplasias and the congenital malformations, comparing with the data of neighboring municipalities like Taubaté, Pindamonhangaba and Aguas de São Pedro, belonging to the same region of study. This is a cross-sectional descriptive study on the incidence of neoplasias and congenital malformations, based on data collected from the Health System of the Ministry of Health in 4 municipalities in the State of São Paulo / SP. The results point to a higher incidence of neoplasms and congenital malformations in the Tremembé region. The results indicate the need for analysis between the exposure of the population of the municipality of Tremembé to the chemicals harmful to health used in industry and local agriculture and the number of cases of congenital malformations.

### **P03.2930. Sleep Quality and Duration and the Risk of Breast Cancer in a Population-Based Study**

Xudong Liu

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**Abstract:** Background: The association between sleep and breast cancer is uncertain. This study was to prospectively investigate the joint effects of the quality and duration of sleep on the development of breast cancer. Methods: 90,881 women aged more than 20 years were selected from a prospective cohort in Taiwan. Self-administered questionnaires were used to collect information on duration and quality of sleep as well as potential confounders. Incident cases of breast cancer were self-reported in subsequent medical examinations. Sleep score was constructed to reflect the participants' sleep profiles with regard to both duration and quality via additive model. The proportional Cox regression method was used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs). Results: 292 individuals reported incident cases of breast cancer at follow-up. The sleep score was associated with the risk of breast cancer with exposure-response trend ( $p < 0.001$ ). Every five-unit increment of sleep score was associated with an 8% decreased risk of breast cancer after adjusting for potential confounders. Higher risk of breast cancer were observed in participants in the lowest quartile (HR: 1.52; 95% CI: 1.07-2.14) and second lowest quartile (HR: 1.45; 95% CI: 1.05-2.02) of sleep scores compared with those in the highest quartile. Conclusion: A poor sleep profile is associated with an increased risk of breast cancer. Our findings suggest that improving sleep behavior by considering both duration and quality can be an important approach in the prevention of breast cancer.

### **P03.2940. Serum Concentrations of Polybrominated Diphenyl Ethers (PBDEs) and Breast Cancer Risk in Young Women: Results from the Ontario Environment and Health Study**

Shelley Harris

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**Abstract:** Polybrominated diphenyl ethers (PBDEs) are brominated flame retardants commonly used in a wide range of household products and electronic devices. Some PBDE congeners have endocrine-disrupting properties, suggesting a potential role in the development of hormonally-related cancers. This is the first study to investigate serum PBDE levels in relation to breast cancer diagnosed in women under 45 years of age. Serum samples were collected from 305 incident breast cancer cases (284 pre-menopausal), identified in the Ontario Cancer Registry between 2012 and 2015, and 144 controls. Gas chromatography/electron ionization-mass spectrometry was used to quantify 8 congeners (ng/mL): BDE-28, BDE-47, BDE-85, BDE-99, BDE-100, BDE-153, BDE-154, BDE-183. Samples in which congeners were not detected or had concentrations below the method detection limit were considered unexposed. For each congener odds ratios (OR) and their 95% confidence intervals were estimated using logistic regression, with adjustment for age, serum lipids, body-mass index 2 years earlier, parity, and date of sample collection. Detection prevalence for each congener was as follows: BDE-47 (52.8%), BDE-153 (19.4%), BDE-99 (11.8%), BDE-100 (9.8%), BDE-28 (4.5%), BDE-183 (4.5%), BDE-154 (1.8%). BDE-47 detection was positively associated with breast cancer status (OR=1.65, 95% CI: 0.99-2.74), but this relationship was significant only in pre-menopausal women (OR=1.73, 1.02-2.94). Suggestive associations were also observed for BDE-153 (OR=1.63, 0.89-2.98) and several related congeners. Combined exposure to BDE-153, -154, and -183 was significantly associated with breast cancer risk (OR=1.98, 1.11-3.56; pre-menopausal: OR=2.19, 1.17-4.11). Non-linear relationships with BDE concentrations were evaluated using smoothing splines, but no significant associations ( $p < 0.05$ ) with case status were observed. Our preliminary findings suggest a possible association between serum PBDE levels and risk of breast cancer in young women.

### **P03.2950. Hexavalent Chromium and Stomach Cancer: A Systematic Review and Meta-Analysis**

Mina Suh

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Abstract: Hexavalent chromium [Cr(VI)] is a carcinogen known to cause lung cancer in workers of certain industries. An association with stomach cancer is uncertain. Systematic review and meta-analyses were conducted to evaluate the association between Cr(VI) and risk of stomach cancer. Documented in the protocol (PROSPERO #CRD4201605162), PubMed, Embase®, and hand searching were used to identify studies. Eligibility criteria included studies of: 1) animals with ingestion exposures to Cr(VI) (n=3); 2) non-occupational populations with ingestion exposures to Cr(VI) (n=6); 3) workers in occupations recognized as having exposure to Cr(VI) (n=50; 3 case-control, 47 cohort). Critical appraisal and qualitative integration were carried out using the National Toxicology Program's Office of Health Assessment and Translation approach; 9 meta-analyses were conducted based on the occupational data. Of the animal studies, one study with low risk of bias was negative, one study with high risk of bias reported forestomach tumors but showed poor internal validity; another study was negative. Non-occupational data were ecologic studies with conflicting results; they were unsuitable for meta-analysis. Critical appraisal of the occupational data with regards to internal validity showed that most studies were categorized as Tier 3 (n=37) or Tier 2 (n=12) with high or probably high risk of bias observed for confounding and exposure characterization domains; overall confidence in this body of evidence was moderate. Meta-analyses consistently showed no significantly increased stomach cancer risk. The overall meta-relative risk (meta RR, excluding Tier 3 studies) for stomach cancer was 1.03 (95%CI 0.84-1.26). Notably, for studies of workers (n=22) from industries with clear evidence of elevated lung cancer due to Cr(VI) exposure, meta-RR was not significantly elevated (1.07, 95%CI 0.89-1.27). Combining the streams of evidence, a lack of association between Cr(VI) and stomach cancer is shown.

**P03.2970. Airborne Dioxin Exposure and Breast Cancer Risk in a Case-Control Study Nested within the French E3N Prospective Cohort**

Béatrice Fervers

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**Abstract:** Objectives: Dioxins, Group 1 carcinogens, are emitted by industrial combustion processes and suspected to increase breast cancer (BC) risk through receptor-mediated pathways. We aimed to estimate BC risk associated with airborne dioxin exposure, using geographic information system (GIS) methods and historical exposure data. Methods: We designed a case-control study (429 BC cases diagnosed between 1990 and 2008, matched to 716 controls) nested within the E3N (Etude Epidémiologique auprès de femmes de la Mutuelle Générale de l'Education Nationale) cohort. Airborne dioxin exposure was assessed using a GIS-based metric including participants' residential history, technical characteristics of 222 dioxin sources, residential proximity to dioxin sources, exposure duration and wind direction. We first estimated odds ratios (OR) and 95% confidence intervals (CI) associated with quintiles of cumulative exposure using logistic regression. We then estimated effects of annual exposure on BC risk according to time prior to diagnosis using a flexible time-dependent weight function. Results: We observed no increased risks of BC for higher dioxin exposure levels overall and according to hormone-receptor status. We however observed statistically significant ORs for Q2 versus Q1 overall (1.61, 95% CI: 1.04-2.49) and for estrogen-receptor (ER) positive BC (1.95, 95% CI: 1.08-3.51). ORs associated with an increase of 0.1 µg-TEQ/m<sup>2</sup> in the annual intensity of exposure in each year before diagnosis were all not statistically different from one, whatever the timing of exposure. Conclusions: No association was observed between airborne dioxin exposure and BC risk in our study. Suggested increased risks for low exposure levels for overall and ER-positive BC might be compatible with non-monotonic dose-response relationship. Confirmation of our findings is required. Our study may provide an alternative in absence of ambient dioxin monitoring and may allow assessing exposure to other pollutants.

**P03.2980. DNA Methylation Mediates Effects of Smoking on Gene Expression in Lung Cancer Tissues**

Wen-Chi Pan

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**Abstract:** Background: Smoking is a well-known risk factor contributes to the development of lung cancer globally, and DNA methylation could serve a potential underlying mechanism. Previous evidences were mostly based on the peripheral blood samples to support this hypothesis. However, only limited studies focused on the interplay between smoking and DNA methylation on lung cancer etiology. Objective: To assess the association of smoking with gene expression in lung cancer tissues, and evaluate the mediation roles of DNA methylation on smoking-lung cancer pathway. Materials and Methods: We extract the information of lung cancer participants regarding their smoking intensity (pack-year), DNA methylation, gene expression, and demographic from The Cancer Genome Atlas (TCGA) (1991-2013). The linear regression models were applied to assess the association for smoking, DNA methylation, and gene expression adjusting for the potential confounders. An external dataset (GSE66836) was used for the further validation. We applied the causal mediation analysis to quantify the natural indirect effect (NIE) for the externally validated CpG sites. Results: A total of 616 lung cancer patients including lung adenocarcinoma (n=306) and squamous cell cancer (n=310) were identified in TCGA. We found that 4,332 CpG sites were statistically associated with smoking and gene expression in TCGA dataset (p-value <0.05). Among those locus, a total of 6 CpG sites located in 5 different genes (PRMD16, CDK6, NETO2, CD109, and FAM171B) imposed statistically significant mediation effects (i.e. NIE) on smoking-gene expression association (p-value <0.05) in external validation dataset, with proportion of mediation greater than 100%. Conclusions: DNA methylation plays an important role on how smoking affects gene expression in lung cancer tissues. Future studies could further evaluate other mechanisms linking smoking and lung cancer beyond the scope of DNA methylation.

### **P03.2990. Polymorphisms of Genes Related to Nucleotide Excision Repair and Cell Cycle Pathways, Arsenic Exposure, and Bladder Cancer**

Ya-Yun Cheng

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**Abstract:** Arsenic is a human carcinogen, and previous studies have demonstrated that it may act through the inhibition of DNA repair mechanisms and the disruption of mitosis to induce apoptosis and centrosome aneuploidy. DNA adducts caused by chemical carcinogens are repaired primarily through the nucleotide excision repair (NER) pathway. Aneuploidy is a common phenomenon regulated by Aurora A (STK15) in cancer cells. The tumor suppressor p53 is an important regulator of the cell cycle and apoptosis and is frequently inactivated in human cancers. We conducted a study in southwestern Taiwan to evaluate whether genetic polymorphisms in the NER (ERCC1 Asn118Asn, XPD Lys751Gln, and XPC Ala499Val) and cell cycle (functional STK15 Phe311Ile and p53 Pro72Arg) pathways have associations with bladder cancers related to arsenic exposure. We recruited 104 bladder cancer patients and 265 cancer-free controls. A questionnaire was used to collect data on demographics, life style, and environmental factors. Genotypes were determined using PCR-RFLP. The arsenic level in drinking water of each participant was assessed on the basis of the address. We found that older age, male sex, lower education level, smoking, and arsenic exposure (with dose-response relationship,  $p < 0.05$  for test for trend) were risk factors of bladder cancer. Among the NER pathway polymorphisms, we found ERCC1 Asn118Asn was associated with bladder cancer (odds ratio [OR] = 5.4; 95% confidence interval [CI]: 2.7-11.0) after adjusting for the arsenic level in drinking water and other risk factors. Among the cell cycle pathway polymorphisms, we found STK15 Phe311Ile (T>A) mutant type (AA) (OR=2.7; 95% CI: 1.1-7.1) was associated with a higher risk of bladder cancer.

**P03.3000. Herbal Medicine Containing Aristolochic Acid and the Risk of Hepatocellular Carcinoma in Patients with Hepatitis C Virus Infection: A Nationwide Population-Based Cohort Study in Taiwan**

Pau-Chung Chen

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**Abstract:** Background: The purpose of this study was to investigate the association between the use of herbal medicine containing aristolochic acid (AA) and the risk of hepatocellular carcinoma (HCC) among hepatitis C virus (HCV)-infected patients. Methods and Findings: We conducted a nationwide population-based cohort study on patients older than 18 years who had a diagnosis of HCV infection between January 1, 1997 and December 31, 2010. A total of 223,467 HCV-infected patients were identified by using the National Health Insurance Research Database in Taiwan. The use of herbal medicine containing AA was identified between 1997 and 2003 and had visited traditional Chinese medicine clinics before one year before the diagnosis of HCC or the censor dates. Each patient was individually tracked from 1997 to 2013 to identify incident cases of HCC since 1999. There were 25,502 HCCs during the follow-up period of 3,052,132 person-years and the overall incidence rate was 835.5 HCCs per 100,000 person-years. The adjusted hazard ratios (HRs) were 1.21 (95% confidence interval [CI], 1.18 to 1.24), 1.48 (95% CI, 1.37 to 1.59), 1.50 (95% CI, 1.34 to 1.68), and 1.88 (95% CI, 1.61 to 2.19) for estimated AA of 1 to 250, 251 to 500, 501 to 1,000, and more than 1,000 mg, respectively, relative to no AA exposure. Conclusions: Our study suggests that AA exposure in association with HCV plays an important role in the carcinogenesis of HCC.

### **P03.3010. Residential Proximity to Animal Feeding Operations and Cancer Risk in the Agricultural Health Study**

Jared Fisher

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**Abstract:** Background: Concentrated animal feeding operations (AFOs) are major sources of hazardous emissions into the surrounding environment, but few studies have investigated cancer risk associated with living near intensive animal agriculture. Methods: We evaluated the association between residential proximity to AFOs and cancer risk among licensed pesticide applicators (mostly male farmers) in the Agricultural Health Study cohort. We linked enrollment (1993-1997) addresses for 32,674 participants in Iowa to a statewide database of permitted AFOs that included animal counts standardized by animal size and manure production (animal units; AUs). We created metrics to reflect exposure proximity and intensity, enumerating AFOs and animal density (quartiles of AUs) within 2 and 5km of residences. Cox regression was used to estimate associations (hazard ratio, HR; 95% confidence interval, 95%CI) with incident cancer for major tumor sites, adjusting for demographic and farming-related factors (e.g., raising animals and occupational pesticide exposure). Results: There were 4,741 incident cancers from 1993-2015. We observed increased risk for non-Hodgkin lymphoma among those residing within 5km of at least one AFO (HR=1.9; 95%CI=1.3-3.0), but without a statistically significant trend across AU quartiles (ptrend=0.31). Prostate cancer risk was significantly elevated in the highest AU quartile (HR=1.4; 95%CI=1.1-1.6; ptrend=0.01). Lung cancer associations showed an inverse, monotonic trend with increasing AUs (HRQ4=0.74; 95%CI=0.5-1.1; ptrend=0.04). Adjustment for contact with animals and occupational use of pesticides previously associated with these cancers did not change the results, and patterns were similar for exposures within 2km. We found no associations for other cancers. Conclusions: Our findings suggest that residential proximity to AFOs may influence risk of cancer at certain sites, even after consideration of animal contact and occupational exposure to pesticides.

### **P03.3020. Residential Position in a Time Zone and Breast Cancer Risk in the United States**

Trang VoPham

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**Abstract:** Background: The natural light/dark cycle is the most important environmental cue for entrainment of circadian rhythms. Residents in the western vs. eastern portion of a time zone receive less light exposure in the morning and greater light exposure at night. This differential exposure to light, despite similar work and social hours, may lead to chronic misalignment of the circadian system, and impact breast cancer risk through DNA damage and endocrine disruption mechanisms. Shift work and western time zone position have been associated with breast cancer. Our aim was to prospectively examine the association between residential position in a time zone and breast cancer risk. Methods: We analyzed data from 112,663 participants (1989-2013) in the Nurses' Health Study II, a nationwide prospective cohort of US female nurses. Distance from time zone meridian was estimated using geocoded residential addresses updated throughout follow-up in a geographic information system. Self-reported breast cancer was confirmed from medical records. Estrogen receptor (ER) and progesterone receptor (PR) status were determined via immunohistochemical analysis of tissue microarrays, pathology reports, or medical records. Time-varying Cox regression models were used to calculate hazard ratios (HRs) and 95% confidence intervals (CIs) adjusted for numerous breast cancer risk factors. Results: There was no association between residential distance from time zone meridian and invasive breast cancer risk overall (n=3,950 cases; adjusted HR per 5-degree increase in longitude moving east to west within a time zone 0.96, 95% CI 0.93, 1.00) or with breast cancers defined by ER/PR status. This association was not modified by shift work, chronotype, outdoor light at night, time zone, residential mobility, or menopausal status. Conclusions: Residential position in a time zone does not appear to be associated with breast cancer risk.

### **P03.3030. Thyroid Cancer Under 19 at the Accident in Fukushima: The Sixth Report - the 2nd and 3rd Round Screening Results**

Toshihide Tsuda

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**Abstract:** Background/Aim After the nuclear power plant accident in Mar 2011, Fukushima Prefecture began thyroid screening (1st round) for all children ages  $\leq 18$  years at the accident until Mar 2014, the 2nd round from Apr 2014 to Mar 2016, and the 3rd round from Apr 2016 to Mar 2017. The data were as of Dec 31, 2018. Methods From report on the 3rd round, Fukushima Prefecture divided the prefecture into 4 areas: (a) Nearest area (i.e., the most contaminated); (b) Middle area; (c) Seafront area excluding the Nearest area; and (d) Aizu area (the West area; the least contaminated). After resequencing the 1st and the 2nd results into the 4 areas, we compared them externally and internally. For an external comparison, we estimated standardized incidence ratios (SIRs) for thyroid cancer, compared with the annual incidence among ages 0-24 in Japan. In the 2nd and 3rd rounds, length of time elapsed between the accident and timing of screening became more comparable across different areas in Fukushima Prefecture. Results Seventy-one thyroid cancer cases were detected in the 2nd, and 10 cases were detected in the 3rd (still in the process of counting). Among the 81, 59 were operated and confirmed histologically (papillary cancer except one). All except three underwent screening of the round before. Sixty-three (81%) of the 78 cases did not have any nodules in the previous round. SIRs (95% confidence interval: Number of cases) for each area were (a) 60.5 (35.2-96.8: 17), (b) 38.9 (27.7-53.2: 39), (c) 25.8 (12.4-47.5: 10), and (d) 22.9 (7.4-53.4: 5) in the 2nd round, and (a) 22.9 (6.3-58.8: 4), and (b) 7.5 (2.7-16.2: 6) in the 3rd ((c) and (d) were 0 cases) under the assumption that no cancer cases exist in the rest of examinees. Dose (distance from the plant as proxy)-response (excess thyroid cancer incidence) was observed about threefold in internal comparison. Conclusions High SIRs and dose-response in the 2nd and the 3rd rounds were unlikely explained by a "screening effect" alone.

### **P03.3040. Prevalence of Breast Benign Findings in Women Residing in an Area of Chronic Exposure to HCH, DDT and Dioxin**

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Abstract: Organochlorine compounds are known for their hormone-active properties, with emphasis on their performance as environmental estrogens. It is discussed whether its prolonged action in the body could lead to lesions in the breast tissue associated with the proliferative effect of estrogens on the epithelial cells of the breast. This study aimed to estimate the occurrence of benign breast diseases (BBD) in women living in an area with a history of chronic exposure to Hexachloroexan, DDT and Dioxin. A cross - sectional study was carried out in Cidade dos Meninos (CM), a district located in the municipality of Duque de Caxias (MDC), State of Rio de Janeiro - Brazil. Women 35 years of age or older residing on the site were eligible for the study. Mammography and / or ultrasound examinations were performed for investigation and categorization according to the Birads classification. We compared the mammographic findings classified in categories 2, 3 and 4 with the results classified in category 1 (without findings). The results obtained in this study population were compared with the results of the Municipality of Duque de Caxias, which were obtained through the SISMAMA / DATASUS data from July 2014 to July 2015, equivalent to the period of data collection in the exposed population . For this comparison the ratios of ratios and 95% confidence interval (95% CI) were used. A total of 111 women aged 35-79 years (M - 52 years; SD - 10.6) participated in the study. The prevalence of BBD was higher in the study population compared to MDC (OR = 1.49 - 95% CI 1.305 - 1.699). The results of the comparison of the study population with the municipality of Duque de Caxias suggest a higher prevalence of DBM in the studied population, corroborating with the hypothesis of association of the exposure to the occurrence of proliferative DBM.

### **P03.3050. Gene-Environmental Interaction among Women with Benign Breast Disease in Brazil**

Ilce Silva

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**Abstract:** AIM: To analyze the interaction between SNP Arg72Pro and selected environmental factors in women with benign breast disease(BBD). METHODS: An exploratory cross-sectional study on cohorts of 303 women diagnosed with proliferative BBD from two public hospitals in Rio de Janeiro. Patients were interviewed by three trained nurses to collect environmental's exposure and blood sample were taken afterwards. DNA extraction was performed by the salting-out technique and genotyping was proceeded by PCR-RFLP. The presence of the wild Arg/Arg genotype was indicated by two bands of 169 bp and 127 bp, the the mutant Pro/Pro genotype was observed by a single band of 296 bp and the Arg/Pro genotype was observed by the presence of these three bands. Interaction ORs and respective 95% confidential intervals were estimated using the non-conditional Multiple Logistic Regression. RESULTS: Frequency of Polymorphic allele (Pro) was 40%, while the frequencies of genotypes were 37.4% (Arg/Arg), 45.2 (Arg/Pro) and 17.4% (Pro/Pro). An interaction was observed between Arg/Pro genotype and exposure to solvents [OR = 2.99 (95% CI, 1.35-6.65)], and age at tobacco smoking onset >18 years old [OR=4.16;(95%CI, 0,66-26.14)]. Compared to women Arg/Arg, the chance of proliferative disease was independently higher among women Arg/Pro as [OR=2.19;(95%CI, 1.16-4.16)], while the dominant model was statistically associated to proliferative breast disease [OR=2.03;(95%CI, 1.11-3.69)]. CONCLUSION: Solvent exposures seems to interact with heterozygous genotype of SNP Arg72Pro, while tobacco smoking still needs to be explored. The heterozygous genotype (Arg/Pro) independently increased the chance of proliferative breast disease, as well as the dominant model of SNP Arg72Pro.

### **P03.3070. Prenatal Exposure to Organophosphate Esters and Cognitive and Behavioral Development**

Kate Hoffman

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**Abstract:** Background: Limited evidence suggests that organophosphate esters (OPEs) may be neurotoxic or endocrine-disrupting, and may interfere with cognitive and behavioral development in humans. Objective: To estimate the effect of maternal OPE metabolite levels during pregnancy on cognitive and behavioral development in offspring. Methods: Women provided a urine sample during pregnancy that was analyzed for concentrations of OPE metabolites (n=349), including diphenyl phosphate (DPHP), bis(1,3-dichloro-2-propyl phosphate) (BDCIPP), 1-hydroxyl-2-propyl bis(1-chloro-2-propyl) phosphate (BCIPHPP), and isopropyl-phenyl phenyl phosphate (ip-PPP). Approximately 36 months after birth, assessments of cognitive development using the Mullen Scales of Early Learning (MSEL; n=341) and behavioral development using the Behavioral Assessment Scale for Children (BASC; n=332) were obtained. Generalized Linear Models were used to estimate associations between ln-transformed, specific gravity-corrected OPE metabolite concentrations and children's scores on the neurodevelopmental assessments, adjusted for maternal age, maternal race, maternal education, familial poverty, child's age at testing, and child's sex. Results: ip-PPP was inversely associated with scores on the MSEL Cognitive Composite ( $\beta=-4.6$ ; 95% CI: -7.9, -1.3), Expressive Language ( $\beta=-2.5$ ; 95% CI: -4.3, -0.7), and Fine Motor ( $\beta=-3.3$ ; 95% CI: -5.7, -0.9) scales. Other compounds were not associated with MSEL scales. Both DPHP and BDCIPP were significantly positively associated with Attention Problems and Atypicality Scores. BDCIPP was also positively associated with Aggression, Withdrawal, Externalizing, and Behavioral Symptoms Index scores. ip-PPP was inversely associated with scores on Anxiety, Depression, and Internalizing Problems. Conclusions: We identified several associations suggestive of adverse neurodevelopmental effects of prenatal exposure to OPEs that warrant further investigation for neurotoxicity.

**P03.3080. Gene-Environmental Interaction between Cyp1a1, Cyp1b1, and Cyp2b6 Polymorphisms and Vitamin D on Insulin Resistance: A Panel Study of an Elderly Population**

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**Abstract:** Objective: As evidence on effect of vitamin D deficiency over insulin resistance(IR) or diabetes mellitus is accumulating, investigation for any gene-environmental contribution to disease development should be accompanied. We thus evaluated the influence of certain cytochrome P450 polymorphisms and vitamin D levels on IR. Methods: Glucose, insulin as well as 25-hydroxyvitamin D levels [25(OH)D] levels from serum, and CYP1A1, CYP1B1, CYP2B6 single-nucleotide polymorphisms (SNPs) from lymphocyte DNA were measure in 535 Seoul residents over 60 years old. Homeostasis model assessment for insulin resistance(HOMA-IR) was calculated, and repeated measure analyses were used to determine the statistical association. Results: Relationship between 25(OH)D insulin ( $\beta = -0.84$ ,  $P = 0.02$ ) or HOMA-IR ( $\beta = -0.26$ ,  $P = 0.04$ ) was inversely significant, and influence of CYP1A1 (rs1048943), CYP1B1 (rs162561, rs2551188) and CYP2B6 (rs3745274) SNPs on IR was found across different genotypes. Estimated effect of 25(OH)D levels on IR in the group with higher risky genotype scores of selected SNPs was greater than the group with lower genotype score. Interaction effect between vitamin D levels and genotype variations was also observed ( $P$ -interaction  $<.05$  for both insulin and HOMA-IR). Conclusion: Genetic variations in CYP1A1, CYP1B1 and CYP2B6 and the serum levels of 25(OH)D showed interactive effect on IR.

**P03.3090. Joint-Associations of Metal Exposure Biomarkers and Systolic Blood Pressure in the United States: Findings from the 1999-2004 National Health and Nutrition Examination Survey (NHANES)**

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Abstract: Characterizing the joint toxicity of multiple exposures can be challenging due to the large number of potential exposures and limited prior knowledge of how those combined effects may manifest. One approach to modeling exposure combinations is recursive partitioning, but these algorithms traditionally have not been appropriate for data collected via a complex survey design. We used recursive partitioning for modeling survey data (RPMS) which appropriately accounts for the clustering, strata, and unequal probability of selection inherent in complex national survey data to estimate the joint associations between 11 metals biomarkers with systolic blood pressure (SBP) in the National Health and Examination Survey (1999-2004), adjusting for age, sex, race, and smoking status. We found that those with urinary lead (Pb) > 0.99 µg/g creatinine had a mean SBP = 123.17 mmHg, while those with Pb ≤ 0.99 µg/g creatinine had a mean SBP = 117.79 mmHg, conditional on having higher barium (Ba > 1.19 µg/g creatinine) and antimony (Sb > 0.11 µg/g creatinine). Interestingly, Pb was not significantly associated with SBP in traditional survey linear regression using the above threshold ( $\beta_1 = 0.70$ , 95% CI = -0.93, 2.32) or log-transformed Pb ( $\beta_1 = -0.19$ , 95% CI = -1.26, 0.88). We also observed that the joint-associations differed by race and Hispanic origin, although Pb was always involved. The highest predicted SBP was conditional on blood Cd > 0.25 µg/L and blood Pb > 1.75 µg/dL for black Americans (SBP = 128.66 mmHg), on urinary Ba > 1.44 µg/g creatinine and urinary Pb > 1.25 µg/g creatinine among Mexican Americans (SBP = 125.99 mmHg) and on urinary Ba > 1.51 µg/g creatinine, urinary Pb > 0.67 µg/g creatinine, and urinary Sb > 0.16 µg/g creatinine for non-Hispanic white Americans (SBP = 123.60 mmHg). This work demonstrates the utility of survey-consistent recursive partitioning to identify joint-associations in large survey datasets with rich environmental exposure data.

### **P03.3100. Contribution of Glutathione and Metallothionein to Acute Toxicity of Cadmium**

Maki Tokumoto

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Abstract: Cadmium (Cd) is a harmful heavy metal widely present in the environment. Liver and kidney are the target tissues of acute and chronic Cd exposure, respectively. Glutathione (GSH) and metallothionein (MT)-I/II are known as defensive factors against Cd, but no studies have been conducted to compare them at the same time. In this study, to clarify the contribution of GSH and MT-I/II to acute toxicity of Cd, we examined using GSH-depleted mice and MT-I/II null mice. GSH-depleted mice were prepared by subcutaneously administering L-Buthionine-sulfoximine after 20 h of fasting to 10-week-old female C57BL/6J wild-type mice. GSH-depleted mice, MT-I/II null mice, and wild-type mice were subcutaneously treated with 17.5  $\mu\text{mol}$  Cd/kg. Twenty-four hours later, GOT and GPT activities, and urea nitrogen (BUN) and creatinine (Cre) levels in the serum were measured as an indicator of hepatotoxicity and nephrotoxicity. Cd did not induced hepatotoxicity and nephrotoxicity in wild-type mice. On the other hand, GOT and GPT activities, and BUN and Cre levels in GSH-depleted mice and MT-I/II null mice were significantly increased by Cd. Both hepatotoxicity and nephrotoxicity in GSH-depleted mice treated with Cd were stronger than those in MT-I/II null mice. All of GSH-depleted MT-I/II null mice died by Cd. These results suggested that GSH plays an important role as a biological protective factor against acute toxicity of Cd compared with MT-I/II.

### **P03.3110. The Involvement of Glucose Transporter Gene Expression in Cadmium Renal Toxicity**

Masahiko Satoh

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**Abstract:** Cadmium (Cd) is an environmental contaminant known to exert renal toxicity. Proximal tubular cell damage is characterized as Cd-induced renal toxicity. Previous studies revealed that Cd caused the gene expression disruption in proximal tubular cells. However, the transcription factors that regulate the expression of genes associated with Cd renal toxicity are poorly understood. Our previous study demonstrated MEF2A (myocyte enhancer factor 2A) transcription factor that is involved in Cd toxicity in HK-2 human proximal tubular cells, using protein/DNA binding array and RNAi method. In this study, it was investigated which downstream factor of MEF2A is involved in Cd toxicity in HK-2 cells. MEF2A is reported to regulate the gene expression of SLC2A4, which encodes GLUT4 (glucose transporter 4) protein. We found that SLC2A4 expression is regulated by MEF2A in HK-2 cells. Moreover, Cd decreased not only the mRNA level of SLC2A4 but also the protein level of GLUT4 in HK-2 cells. In addition, SLC2A4 knockdown by siRNA conferred the toxicity to HK-2 cells. On the other hand, GLUT2 protein is reported to be expressed abundantly in the mammalian kidney. However, the knockdown of the GLUT2 encoding gene, SLC2A2, did not induce the toxicity in HK-2 cells. Furthermore, MEF2A knockdown did not inhibit the gene expression of SLC2A2 in HK-2 cells. These results suggest that the pathway of Cd renal toxicity through the decrease in activity of MEF2A involves the suppression of SLC2A4 gene expression.

**P03.3120. Urinary Isoflavones Levels in Relation to Thyroid Function in Adults from NHANES 2007-2010**

Patricia Janulewicz

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**Abstract:** Background: Isoflavones are phytoestrogens commonly found in plant-based foods and nutritional supplements. Some studies have reported inverse associations between isoflavone intake and selected health outcomes, including cancer, cardiovascular disease, and osteoporosis. However, there is growing concern that isoflavones may affect thyroid status. Experimental studies have shown a relationship between isoflavones and hypothyroidism, but human studies have reported conflicting results. Method: Using cross-sectional data from the National Health and Nutrition Examination Survey (2007-2010), we examined the association between urinary isoflavone concentrations and serum measures of thyroid function in adults free of thyroid disease. Specifically, we conducted multivariable analyses relating the concentrations of each urinary isoflavone (genistein, daidzein) and their metabolites (equol, O-desmethylangolensin [O-DMA]) to serum concentrations of thyroid stimulating hormone [TSH], free triiodothyronine [T3], total T3, free thyroxine [T4], total T4, thyroperoxidase [TPO] antibodies, adjusting for sociodemographics, creatinine, iodine and thiocyanate. Results: We observed positive associations between daidzein and O-DMA and free T4, and an inverse association between equol and total T4. Daidzein and O-DMA associations were stronger among women: A 10-fold increase in daidzein was related to a 3.2% (95% CI: 1.9%, 4.5%) increase in free T4, and a 10-fold increase in O-DMA was related to a 2.0% (95% CI: 1.1%, 2.9%) increase in free T4. The equol association was stronger among men: A 10-fold increase in equol was related to a 1.8% decrease (95% CI: -3.4%, -0.13%) in total T4. Conclusion: In the present study, isoflavone intake was associated with selected thyroid hormones in a sex-dependent fashion.

### **P03.3130. Urinary Lignan Levels and Thyroid Function in Adults from NHANES 2007-2010**

Jeffrey Carlson

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**Abstract:** Background: Enterodiol and enterolactone are lignans, a group of phytoestrogens produced by bacteria in the colon that act on plant precursors. Flaxseed is the largest dietary source of lignans, but are also found in other seeds, grains, fruits, and vegetables. Health effects research on enterodiol and enterolactone is limited. However, some studies find associations between high dietary lignan exposure and reduced risk of thyroid and breast cancer and cardiovascular disease. Method: We performed a cross-sectional analysis examining the relation between urinary lignan concentrations and serum of thyroid levels in adults free of thyroid disease in the National Health and Nutrition Examination Survey (2007-2010). Specifically, we conducted multivariable analyses relating the concentrations of each urinary lignan (enterodiol, enterolactone) to serum concentrations of thyroid stimulating hormone [TSH], free triiodothyronine [T3], total T3, free thyroxine [T4], total T4, thyroperoxidase [TPO] antibodies, adjusting for sociodemographics, creatinine, iodine and thiocyanate. Results: In women, enterodiol and enterolactone were inversely associated with total T4. A 10-fold increase in enterodiol was associated with a 1.8% decrease (95% CI: -2.8%, -0.89%) in total T4, and a 10-fold increase in enterolactone was associated with a 1.6% decrease (95% CI: -2.5%, -0.68%) in total T4. Among men, a 10-fold increase in enterolactone was associated with a 1.0% increase (95% CI: -2.32%, 0.23%) in total T4 and a 10-fold increase in enterodiol was associated with a 2.1% decrease (95% CI: -3.4%, -0.82%) in total T4. In addition, among women, there was an inverse association between enterolactone and free T3, where a 10-fold increase in enterolactone was associated with a 1.6% decrease (95% CI: -2.5%, -0.68%) in free T3. Conclusion: In the present study, urinary lignan concentrations were associated with serum concentrations of selected thyroid hormones in a sex-dependent fashion.

### **P03.3140. Association between Antibiotics in Urines and Adult Obesity in Shanghai**

Hexing Wang

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**Abstract:** Background: Exposure to antibiotics was found to be one possible risk factor of child obesity, but the information on adults is limited. Objective: To investigate the association between antibiotics in urines and adult obesity in Shanghai. Methods: 530 adults aged 21-75 years from two towns located in the suburb of Shanghai were studied in 2017. Their spot urines and demographic data were collected and the anthropometric measurements were performed. 18 common used antibiotics from five categories (4 fluoroquinolones, 4 tetracyclines, 3 phenicols, 3 macrolides, and 4 sulfonamides) were determined in urines by the isotope dilution-based UPLC-Q/TOF MS. These subjects were classified into 3 groups, namely normal weight, overweight, and obesity, based on the body mass index-based cutoff points recommended by the guidelines on prevention and control of overweight and obesity in Chinese adults. The multinomial logistic regression model was used to explore the association of antibiotic concentration sum by category with overweight and obesity. Results: The overall detection frequencies of five antibiotic categories ranged from 1.9% to 28.7%. Compared to the subjects in the tertile 1 of concentration sum of fluoroquinolones, the adjusted odds ratios (ORs) of subjects in tertile 3 were 1.56 (95% confidence interval: 0.90, 2.71; p-Value: 0.116) for overweight and 0.97 (0.42, 2.26; 0.948) for obesity. Similarly, for tetracyclines, the ORs were 6.06 (1.63, 22.52; 0.007) for overweight and 2.88 (0.46, 18.08; 0.259) for obesity and for phenicols, the ORs were 4.50 (1.43, 14.15; 0.010) for overweight and 8.16 (2.20, 30.23; 0.002) for obesity. Sex-specific associations with overweight or obesity were observed for some antibiotics. Conclusion: Some antibiotics in urines were found to be associated with an increased risk of adult overweight or obesity. In view of the cross-sectional design of our study, longitudinal studies are warranted to further test these findings.

**P03.3150. Environmental Risk Factors for Benign Prostate Hyperplasia: A Case-Control Study in Hong Kong Chinese**

Lap Ah Tse

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**Abstract:** Objective: To document associations between environmental risk factors and benign prostate hyperplasia (BPH) among Hong Kong men using a case-control study. Methods: We recruited 431 newly diagnosed prostate cancer cases and 402 age-matched controls from Prince of Wales Hospital in Hong Kong. We further consecutively recruited 855 BPH cases from the urological outpatients who were confirmed by biopsy to be non-malignancy. We adopted a standardized questionnaire to obtain each participant's information on shift work, diets, habits of using food and water containers, household detergents and pesticide usage, etc. We applied a new assessment tool of environmental bisphenol A exposure (BPA) developed in our previous publication on BPA and prostate cancer to each BPH case to calculate a novel cumulative BPA exposure index (CBPAI). Compared with the distribution of exposures among controls, we estimated odds ratio (OR) and 95% confidence interval (95% CI) for BPH using multiple logistic regression analysis. Results: Shift work was more common among BPH cases (12.9%) than the controls (7.5%), showing an adjusted OR of 1.90 (95%CI: 1.23-2.94). Weekly consumption of deep fried food and pickle vegetables was positively associated BPH with OR of 2.25 (95%CI: 1.49-3.38) and 1.85 (95%CI: 1.12-3.05), respectively. Habitually drinking green tea had benefits (OR=0.61, 95%CI: 0.41-0.92) but habitual coffee consumption showed harmful (OR=1.59, 95%CI: 1.17-2.15). A significant positive gradient between exposure to CBPAI and risk of BPH was observed. Conclusions: This study identified weekly consumption of deep fried/persevered foods, habitual coffee drinking and frequent use food/water containers are risk factors of BPH, but habitual green tea drinking is protective. This study is the first to provide an integrated picture on the etiology of BPH. [Acknowledgement: Health and Medical Research Fund (HMRF), Project No.: 11121091; correspondence: shelly@cuhk.edu.hk]

### P03. Biomarkers of Exposure and Effects 3

#### **P03.3160. Biomonitoring of Exposure to Great Lakes Contaminants in New York State Burmese Refugees: Recruitment Strategy, Descriptive Characteristics, and Fish Consumption Patterns**

Sanghamitra Savadatti

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**Abstract:** The Buffalo River in Buffalo, NY is a highly industrialized river and an ongoing Great Lakes Area of Concern. The New York State Department of Health (NYSDOH) conducted a biomonitoring study to assess exposure to persistent contaminants among adult Burmese refugees residing in Buffalo who may have increased risk of exposure due to frequent consumption of locally caught fish. The chemicals measured include metals, polychlorinated biphenyls, persistent pesticides, per- and polyfluoroalkyl substances, and polybrominated diphenyl ethers. An advisory committee provided invaluable assistance throughout program planning, implementation, and outreach. The committee included local refugee resettlement agencies, academia, and state and local health departments. In 2013, 206 participants were recruited using respondent driven sampling, a method suitable for reaching "hidden" populations with no known sampling frame. Survey data collected included residential history, education and employment history, lifestyle factors, and information on catch location and species-specific consumption of locally caught fish. Culturally oriented information was also collected, including country of birth, history of living in refugee camps, preparation and consumption of fish paste, use of Thanakar (a cosmetic), and betel nut (a mild stimulant). The Burmese participants reported eating a substantial amount of locally caught fish with a median of 88 meals in the previous year. A majority of participants (80%) reported eating fish paste (either store-bought or homemade) 52 times per year or more. Over half of the participants were not aware of the health advice on eating fish caught in local waters. The NYSDOH used the biomonitoring data to develop and provide educational materials related to exposure reduction for this population. Information was provided on choosing the right fish species for consumption, recommended local waters to fish from, and the best methods of fish preparation.

### **P03.3170. Use of High-Resolution Metabolomics to Identify Potential Metabolic Pathways Associated with Traffic-Related Air Pollutants**

Donghai Liang

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**Abstract:** Background. High-resolution metabolomics (HRM) has emerged as a promising analytical platform for measuring environmental exposures and corresponding biological response. Questions remain, however, whether HRM can be a sensitive tool for biomarker discovery, especially over short exposure durations. Methods. We conducted HRM to identify potential metabolic pathways and internal biomarkers associated with primary traffic emissions within the Dorm Room Inhalation to Vehicle Emission (DRIVE) study. We measured a suite of air pollutants at multiple ambient and indoor sites along a major highway artery over 12 weeks. In parallel, 54 students living in dormitories either near (20 m) or far (1.4 km) from the highway underwent personal sampling and contributed plasma and saliva. We conducted untargeted HRM on all samples, followed by a Metabolome-Wide Association Study (MWAS), pathway analyses and tandem mass spectrometry (MS/MS). Results. In total, over 20K metabolite features were reliably extracted from plasma, and over 29K from saliva. Over 1300 features were significantly associated with at least one or more traffic pollutant (e.g., black carbon, carbon monoxide, nitrogen oxides ( $p < 0.05$ ), when controlling for covariates and false discovery rate. Pathway analysis indicated elicitation of several inflammatory pathways, including leukotriene metabolism and vitamin E metabolism. We validated 10 metabolites associated with traffic pollutants using MS/MS, including hypoxanthine, g-linolenic acid, L-Histidine, L-Proline, and L-Arginine. Conclusions. We successfully identified and verified several pathways and metabolites using HRM, most consisting of endogenous metabolic signals related to oxidative stress, inflammatory response and nucleic acid damage and repair. These findings offer promising initial evidence of the potential of this analytic platform as a tool for biomarker discovery to ubiquitous environmental stressors.

### **P03.3180. Blood Lead Concentration in Childhood and Age of Menarche in a Prospective Study of U.S. Girls**

Mary Wolff

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Abstract: Lead may alter growth and development, but prospective studies on menarche are lacking. Among girls enrolled at 6-8 years of age in the Breast Cancer and Environment Research Program cohort during 2004-2007 and followed up to 11 years, lead in blood (PbB) was measured in a single sample, primarily before menarche but up to 7 years after. Median PbB was 0.95 ug/dL (IQR 0.69-1.3) and age of menarche 12.2 years (IQR 11.2-13; n=809). Associations of ln(PbB) with menarcheal age were estimated using Cox proportional hazards models adjusted for age and height at PbB sample collection and race/ethnicity. Associations were null in unadjusted models. Adjusted associations were also null among all girls or those whose PbB sample was obtained 2-9 years before menarche (n=654, aHR 1.02 95%CI 0.86 - 1.22). If PbB was measured within 1 year of menarche or after, the association was inverse (n=155, aHR 0.64, CI 0.43-0.96). The latter finding closely resembles those of prior cross-sectional studies and may arise because PbB concentrations decline during childhood when PbB is diluted by body size during maximal growth. The group of 155 girls with PbB obtained near or after menarche differed significantly from the 654 followed prospectively, with older median age at sampling of 11 vs. 8 years old, lower PbB: 0.76 vs. 0.99 ug/dL, taller height: 60 vs. 50 in; and earlier menarcheal age: 11.1 vs. 12.4 years, respectively. Therefore, cross-sectional studies reporting associations of PbB with delayed menarche may not have adequately adjusted for rapid growth or measured PbB in an appropriate susceptibility window. During childhood, intercorrelations among PbB, height, age, and menarche can seriously confound associations. In our longitudinal analysis with pre-pubertal PbB measures there was no association with age of menarche. These findings and conclusions have not been disseminated by the Centers for Disease Control and Prevention and do not represent any agency determination or policy.

**P03.3190. Global Metabolic Profiling of Dried Blood Spot Samples for Personal Air Pollution Exposure in Population Studies**

Jill Baumgartner

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**Abstract:** Background: Exposure assessment and clinical diagnostics are major barriers to assessing the chronic disease impacts of household air pollution, an exposure impacting over half the world's population. The potential of global metabolic profiling of dried blood spots (DBS) for investigating air pollution exposure is of interest to epidemiology and exposure studies due to its relatively simple and low-cost collection method. However, its application and adoption for household air pollution exposure has not been evaluated. Methods: We aimed to assess the metabolic changes associated with exposure to fine particulate matter (PM<sub>2.5</sub>) in a cross sectional study of 33 women in rural China using traditional biomass stoves. We measured women's 48-hour personal exposure to PM<sub>2.5</sub>, blood pressure (BP) and demographic/anthropometric variables in summer 2016 and winter 2016/17, and acquired metabolic profiling of DBS using ultra-performance liquid chromatography-mass spectrometry (UPLC-MS). Results: The mean systolic BP was 111.6 (95% CI 105.8, 117.4) mmHg in summer and 119.6 (95% CI 115.2, 125.3) mmHg in winter; and their corresponding median personal exposure of PM<sub>2.5</sub> was 38.6 (95% CI 30.6, 45.7) mg/m<sup>3</sup> in summer and 145.8 (95% CI 141.2, 167.5) mg/m<sup>3</sup> in winter. Orthogonal partial least square-discriminant analysis (OPLS-DA) on UPLC-MS data comparing women with below median exposure to PM<sub>2.5</sub> in summer with those with above median exposure in winter showed distinct differences in their DBS profiles. The discriminatory metabolites contributed to this separation including hydroxanthine (requires for nucleic acid synthesis and energy metabolism) and sphingolipids (plays a role in protection of cell from harmful external factors). Conclusions: Our UPLC-MS method on DBS for global metabolic profiling in population-based studies of household air pollution may be used to gain mechanistic insights into the health impacts of seasonal PM<sub>2.5</sub> exposure.

**P03.3200. Biomonitoring of Exposure to Great Lakes Contaminants in New York State Burmese Refugees: Assessing Exposure to Per- and Polyfluoroalkyl Substances (PFAS) and Its Association with Local Fish Consumption**

Ming Liu

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**Abstract:** Background: Fish consumption is a potential source of PFAS exposure, but few studies have looked at the associations between fish consumption and PFAS exposure. Burmese refugees and immigrants in Buffalo, NY consume a substantial amount of fish caught from the Great Lakes and surrounding waters, raising their risk of exposure to contaminants including PFAS. The aims of this study were to: (i) present the PFAS exposure profile of the Burmese refugees, and (ii) examine the associations between PFAS levels and local fish consumption. Methods: Burmese participants (n=199) provided blood samples and completed a detailed questionnaire. We measured 12 PFAS compounds in serum. Multiple linear regression was used to assess associations between PFAS concentrations and self-reported consumption of fish from the Great Lakes waters. Results: Local fish consumption was high among study participants (median: 3 meals/week in summer, 1 meal/week in winter). Nine PFAS were detected in at least 65% of participants. PFOS had the highest median concentration (35.6 µg/L), 6 times that of the U.S. general population. We selected the 5 most abundant PFAS (PFOS, PFHxS, PFOA, PFNA, and PFDA) with 100% detection rate for further regression analysis. Consumption of fish/shellfish within the past 3 days was associated with elevated PFOS and PFNA. There was evidence of potential effect modification by ethnicity (Karen and Other). Higher consumption of Great Lakes fish in summer and consuming fish/shellfish within the past 3 days were associated with PFOS and PFDA among the Burmese of 'Other' ethnicity, but not among participants of Karen ethnicity. Conclusions: Burmese refugees and immigrants in western New York had elevated blood PFAS concentrations (especially PFOS) and some PFAS were associated with Great Lakes fish consumption. Besides local fish consumption, there may be other PFAS exposure routes related to ethnicity in this population.

### **P03.3210. Maternal Diet during Pregnancy and Blood Cadmium Concentrations in a Cohort of British Women**

Katarzyna Kordas

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Abstract: Food is the main source of cadmium (Cd) exposure in non-smoking populations. We examined maternal diet in pregnancy as predictor of blood Cd (BCd) in women from the Avon Longitudinal Study of Parents and Children (ALSPAC). Women reported on frequency of consumption of 43 foods and drinks, later combined into 10 groups: meats; fish; pulses; nuts; soybean products; root vegetables; leafy greens and green vegetables; breads and cereals; cakes and biscuits; pastas/rice. PCA was used to derive five dietary patterns: 'health conscious' (high in salad, fruit, rice, pasta, oat and bran-based breakfast cereals, fish, pulses, fruit juices and non-white bread); 'traditional' (high in vegetables and red meat and poultry); 'processed' (high in high-fat processed foods, such as meat pies, sausages and burgers, fried foods, pizza, chips and baked beans); 'confectionery' (high in foods with high sugar content: chocolate, sweets, biscuits, cakes and other puddings) and 'vegetarian' (high in meat substitutes, pulses, nuts and herbal teas; low in red meat and poultry). BCd was measured via ICP-MS in whole blood taken in early pregnancy (median 11 wks). Samples median in relation to diet. Sensitivity analysis excluded smokers. Closer adherence to the 'health conscious' pattern (covariate-adjusted OR [95% CI]: 0.56 [0.39-0.81]), frequent consumption of leafy greens and green vegetables (0.72 [0.56-0.92]) or meat (0.66 [0.46-0.95]) were associated with lower likelihood of elevated BCd compared with reference groups. Sensitivity analysis mirrored main findings. Adherence to a healthy diet in pregnancy is related to lower Cd levels.

**P03.3220. Association between Blood Heavy Metal Concentrations and Metabolic Syndrome Related Biomarkers among Reproductive Age Women of Korea**

Inae Lee

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Abstract: Metals have been reported for possible associations with metabolic symptoms, but existing information remains contradictory. In the present study, the association between metal exposure and the metabolic symptom related biomarkers among reproductive age women was investigated. The participating women (n=516, aged 20s to 40s) were recruited from major cities throughout Korea between 2015 and 2016, and measured for lead (Pb), cadmium (Cd), and mercury (Hg) in blood samples. Metabolic syndrome (MetS) related biomarkers such as adiponectin, leptin, glucose, insulin, high density lipoprotein (HDL)-cholesterol, triglycerides (TG), and total cholesterol (TC) were also analyzed in serum. The participants were instructed to fast at least 9 hours before the blood sampling. Logistic regression was used to assess the association between blood heavy metal concentrations and the MetS related biomarkers. Blood Pb and Hg concentrations in quartiles were positively associated with homeostasis model assessment-insulin resistance (HOMA-IR), which was defined as exceeding the 75 percentile of HOMA-IR, after adjusting for age, body mass index (BMI), alcohol consumption status, and smoking. These observations suggest that exposure to Pb and Hg may be associated with MetS among reproductive age women. Further studies for confirming this association in other populations are warranted.

**P03.3230. Temporal Variation of Total Mercury Levels in the Hair of Pregnant Women from the MIREC (Maternal-Infant Research on Environmental Chemicals) Study**

Cheryl Khoury

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Abstract: Prenatal exposure to mercury (T-Hg) comes from both natural and anthropogenic sources. T-Hg can cross the blood-placental barrier, transfer from mother to fetus, and may be associated with future neurological (memory loss, personality changes, deafness and vision loss, attenuation of IQ) and physiological (delays in walking and talking, tremors and convulsions) dysfunctions. Hair is an optimal and non-invasive indicator of chronic T-Hg exposure. On average, scalp hair grows about 1.1 cm per month. As part of the Maternal-Infant Research on Environmental Chemicals (MIREC) Study, hair samples of 350 women were collected within weeks after giving birth, to determine temporal variation of T-Hg from conception to delivery, and to compare these levels to levels measured in other matrices (maternal and umbilical cord blood, breast milk, and infant's meconium). One centimeter sequential hair samples were collected, starting at the scalp and up to 12 cm. Overall, T-Hg levels decreased over the course of pregnancy. Mercury levels in hair positively correlated with levels in blood, but not with levels in meconium or breast milk. A higher mean mercury level was found in cord blood, meaning that it was able to pass the placental barrier, but did not reach the fetus, since the majority of meconium samples had mercury below the detection limit. This study generates knowledge on the monthly variation of mercury in a pan-Canadian pregnancy cohort and provides a unique opportunity to compare mercury levels from multiple matrices from pregnant women and their infants.

### **P03.3240. Perfluorinated Alkyl Substances and Association with Response Biomarkers among NHANES 2005-2010 Subjects**

Dina Schreinemachers

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Abstract: Presence of perfluorinated alkyl substances (PFAS) in the environment is widespread. These stable chemicals have half-lives in the human body of several years. Their presence has been linked to several diseases. This study explores the link between PFAS exposure and disease, by use of biomarkers. Male and nonpregnant female subjects were selected if they had been tested for PFAS, were between ages 20 and 49, and had not experienced any chronic diseases. From the 12 available PFAS, five were selected based on their high percentage ( $\geq 75\%$ ) above the limit of detection: perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHS), perfluorodecanoic acid (PFDE), perfluorononanoic acid (PFNA). By standardizing and summing up these chemicals, an overall exposure measure (PFSUM) was created to study associations with early and late response biomarkers. Ferritin, serum creatinine, platelet count, and serum uric acid were selected for the initial association with PFSUM. These biomarkers are known to be associated with the metabolic syndrome and associated diseases. Significant Spearman correlations with PFSUM were observed for the following biomarkers for males: platelets (0.110,  $p < 0.01$ ), serum creatinine (0.205,  $p < 0.0001$ ), serum uric acid (0.112,  $p < 0.01$ ), and for females (ferritin 0.233,  $p < 0.0001$ , serum creatinine 0.201,  $p < 0.0001$ ). Initial observations have shown that these four biomarkers are correlated with biomarkers known to be associated with system damage, such as inflammation, liver function, glucose metabolism, lipid metabolism, and blood pressure. The results indicate that PFAS may be linked to disease by a series of adverse health outcomes. This abstract does not necessarily reflect EPA policy.

**P03.3250. The Association of Urinary Phosphorous-Containing Flame Retardant Metabolites and Self-Reported Personal Care and Household Product Use among Women from the Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) Study**

Mary Ingle

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**Abstract:** Background Phosphorous-containing flame retardants (PFRs) are widely detected among pregnant women in the U.S. PFRs have been associated with endocrine disruption and adverse reproductive health outcomes. Although mainly used as a flame retardant, increased PFR exposure has been associated with personal care product (PCP) use. Methods Pregnant women 18-40 yrs. were recruited from two hospitals and five prenatal clinics in Northern Puerto Rico (n=148). Metabolites bis-2chloroethyl phosphate (BCEtP), bis-(1-chloro-2propyl) phosphate, bis-(1-chloro-2propyl) phosphate, bis(1,3-dichloro-2-propyl) phosphate (BDCIPP), di-n-butyl phosphate (DBNP), di-benzyl phosphate (DBzP), di-cresyl phosphate (DCP) and diphenyl phosphate (DPHP) were measured in urine three times during pregnancy. Participants completed a 48-hour recall questionnaire of PCP and household product (HP) use (visits 1&3). Associations among products and metabolites (n=296) were assessed using linear mixed models, adjusted for specific gravity, age, BMI, income and season. Results BCEtP, BCPP, BDCPP and DPHP were highly detected (79% $\geq$ LOD), yet correlations among metabolites ( $0.16 \leq r \leq 0.35$ ) and within women ( $0.03 \leq r \leq 0.34$ ) were weak-to-moderate. Correlations among visits were moderate ( $0.20 \leq r \leq 0.43$ ). Suntan lotion use was associated with a 110% increase in BDCPP levels while DPHP increased with reported perfume (51%), nail polish (49%) and cosmetic (45%) use ( $p < 0.05$ ). BCPP levels increased 46% with pesticide use in home, yet DPHP decreased 27% with use of vinyl shower curtain ( $p < 0.05$ ). Furniture polish use was associated with an increase in BCEtP (62%) and BCPP (70%). Conclusion PFRs among pregnant women were highly detected, yet concentrations were weakly correlated with high temporal variability between visits 1&3. Associations with PCP and HP suggests PFRs are possibly being used as plasticizers, specifically in perfume, nail polish and cosmetics. Further investigation into these products is warranted.

### **P03.3270. Advancements in Laser-Ablation ICP-MS for Hair as a Biomarker of Past Exposures**

Boris Reiss

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Abstract: Group-based (bulk) hair analysis suggests that hair is a suitable biomarker of past exposure of metals such as lead (Pb), mercury (Hg), and manganese (Mn). However, there is potential to conduct individual-based assessments of exposure to metals using individual hair strands. Such time-resolved exposure analysis involves applying recent developments in laser ablation with inductively coupled plasma spectrometry (LA-ICPMS). Individual hair strands are ablated along the shaft and the aerolized material is analyzed with ICP-MS. The resulting spatial profile along the length of hair strand is expected to present metal exposures over time. Until now, outside hair contamination and calibration issues have limited usability of individual hair strands. Physical properties of individual hair strands cause particulate material to attach to the outside of a strand. Novel washing procedures were developed to remove external hair contamination. Although more than 80 different procedures have been tested over the past decades, their effectiveness is still difficult to assess. In addition, it is challenging to calibrate hair strand analysis against standards, because standard hair strands with known concentrations of metals are not available. We used a novel approach to mounting hair strands and analyzing individual samples in a pilot experiment with hair strands from an Asian woman. Preliminary data suggests that outside particulate contamination can be measured separately from material deposited inside a hair strand. Deposition density of several metals inside a hair strand were determined. In addition, it may be possible to eliminate the need for matrix calibration standards such as standard hair strands. Updates on the development of apprentice welders' hair analysis with LA-ICPMS progress will be added to the presentation.

**P03.3280. Trisaminohexyl Isocyanurate (TAHI) Levels in Plasma and Urine in Workers Exposed to 1,6-Hexamethylene Diisocyanate (HDI) Monomer and HDI Isocyanurate**

Leena Nylander-French

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Abstract: Identification and quantification of trisaminohexyl isocyanurate (TAHI) as a biomarker of 1,6-hexamethylene diisocyanate (HDI) isocyanurate exposure is a critical step for evaluating the contributions of work environment and personal protective equipment practices in limiting isocyanurate exposure. Polymeric HDI isocyanurate is the predominant inhalation and skin exposure in the automotive repair industry, yet, biological monitoring has been limited to metabolites of HDI monomer exposure. We analyzed TAHI and hexamethylene diamine (HDA), a biomarker for HDI monomer exposure, in the plasma and urine of automotive spray-painters. Despite the large number of samples with HDA, daily total urinary HDA and plasma HDA were weakly associated with inhalation exposures to HDI monomer (Urine:  $r = 0.121$ ,  $p = 0.1980$ ; Plasma:  $r = 0.120$ ,  $p = 0.2146$ ) or HDI isocyanurate (Urine:  $r = 0.011$ ,  $p = 0.9112$ ; Plasma:  $r = 0.065$ ,  $p = 0.5015$ ). By comparison, correlations for TAHI were strong with both HDI monomer (Urine:  $r = 0.329$ ,  $p = 0.0003$ ; Plasma:  $r = 0.262$ ,  $p = 0.0062$ ) and HDI isocyanurate inhalation exposures (Urine:  $r = 0.364$ ,  $p = <0.0001$ ; Plasma:  $r = 0.335$ ,  $p = 0.0004$ ). HDA and TAHI levels in urine and plasma had equally strong correlations with HDI monomer and HDI isocyanurate skin exposures. However, due to the collinearity of HDI monomer ( $r = 0.475$ ,  $p = <0.0001$ ) and HDI isocyanurate ( $r = 0.377$ ,  $p = <0.0001$ ) inhalation and skin exposures, the contributions of exposure pathways to biological levels is unknown. Workplace factors such as paint-booth type, coverall and glove use, and respirator type may be equally or more important factors for variation in TAHI levels. Using linear mixed modeling in SAS, we are currently investigating the contributions of exposure pathways and workplace factors on HDA and TAHI levels in plasma and urine in this occupationally exposed worker cohort.

**P03.3290. From Zero to One-Hundred in 15 Years: Urine Samples from the German Environmental Specimen Bank Reveal Omnipresent and Further Increasing Exposures to the Novel Plasticizer Substitute Hexamoll DINCH**

Holger Koch

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Abstract: Hexamoll® DINCH® was introduced in the year 2002 as a substitute for high molecular weight ortho-phthalate plasticizers, which are under scrutiny for their endocrine disrupting effects. In Western Europe, DINCH production rose from 9.000 t in 2002, to 155.000 t in 2014, to a predicted 220.000 t in 2019. In the meantime, human biomonitoring studies have reported on DINCH exposures in several European countries, in the US and in Australia. For Germany, we already reported the rapid increase in detections and levels of DINCH metabolites in 24h urine samples from the Environmental Specimen Bank (ESB) from 1999 to 2012. Here, we report the results of the ESB measurements from the sampling years 2010, 2011, 2013, 2015 and 2017 (a total of 300 24h-urine samples; 60 per year, 30 male and 30 female volunteers, aged 20-29). All samples were blinded and randomized before analysis. Three urinary DINCH metabolites, the side-chain oxidized monoesters OH-MINCH, oxo-MINCH and cx-MINCH, were determined by online SPE LC-MS/MS with isotope dilution quantification. The limit of quantification for all three metabolites was 0.05 µg/L. We first detected the major metabolite OH-MINCH in samples from 2006 (6.7%) with detection rates steadily increasing thereafter (43% in 2009, 80% in 2010, 98% in 2011, 98% in 2012, and 100% in the years 2013, 2015 and 2017). The median concentration for OH-MINCH increased from 0.15 µg/L in 2010 to 0.70 µg/L in 2017. Detection rates and concentrations for the other DINCH metabolites were lower, as expected from human metabolism studies, but strongly correlated among each other. Overall, urinary DINCH metabolite concentrations were well below the health based guidance value (HBM-I) of 4500 µg/L (sum of OH-MINCH and cx-MINCH), and calculated intakes were well below the tolerable daily intake of 1 mg/kg bw\*d. The continuous increase of DINCH exposure calls for a continued exposure monitoring preferably in subpopulations with higher exposure (e.g. children).

### **P03.3300. Accessing Biobanks to Obtain Human Biomonitoring Data**

Kristin Macey

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**Abstract:** Background: The use of human biomonitoring data allows direct and more precise assessment of the distribution of exposure in a given population. In Canada, biomonitoring data in the general population has been continuously measured since 2007, by the Canadian Health Measures Survey (CHMS). Integrated within the CHMS, the biobank is a nationally representative cohort to facilitate novel health research. Objective: Some of the Chemical Management Plan's priority substances; Al, Bi, Ce, Cr, Ge, La, Li, Nd, Pr, Ti, Te and Y were not included in the CHMS. After obtaining approval from relevant authorities, approx. 6000 whole blood samples from the CHMS biobank were accessed to determine metal concentrations by Inductively Coupled Plasma Spectrometry. Method: Resultant concentrations were expected to be at ppt or ppb levels. The main challenges were: possible leaching of metals from storage and associated materials, non-homogeneity of blood samples, transportation of samples and analytical issues related to testing a large batch of samples in the absence of data for comparison. Leaching was addressed by sequential testing of de-ionized water and blood, mimicking the procedure from the withdrawal of the blood samples, storage and analysis. Non-homogeneity of the samples and possible contamination during analysis were addressed by reproducibility studies. Throughout the project (1.5 years), accuracy, recovery, reproducibility, and contamination were assessed using Certified Blood Reference Materials, a control spiked blood sample, and Method Blanks along with each analytical batch. Results: Recoveries were in an acceptable range of 70-130%; the majority between 80-120%, with an inter assay CV% ranging from 3-11%. Leach testing showed no contamination from the storage or associated materials used for Bi, Ce, Cr, Ge, La, Li, Nd, Pr, Te, except for Y, which had minor contamination close to the detection limit from materials associated with blood withdrawal.

**P03.3310. Increasing the Regulatory Impact of Chemical Safety Research by Following a Standard Procedure: A Human Biomonitoring Physiologically Based Kinetic (PBK) Model Case Study**

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**Abstract:** While progress in chemical safety research in recent years has been impressive, especially in the area of in-vitro and 3R approaches, an obvious gap between scientific ambition on the one hand and awareness of regulatory requirements on the other prevents a more widespread application of latest science findings in current regulatory programs: The resulting delay with which new research is acknowledged, and ultimately accepted by regulators is costly in terms of money, accuracy and ethics. We argue that by following a standard procedure (checklist, vademecum or similar) during conception, execution and publication of research results, scientists can make their output regulatory-aware from the onset, and thereby simplify the uptake in affected legislations. After having reviewed current regulatory programs and interviewed relevant stakeholders within them, we developed a checklist of steps researchers can follow in order make their output more relevant for regulators. The checklist consists of a general part, applicable to all categories of chemical risk assessment research and legislations, while a more sector-specific part deals with the individual specificities of the research type at hand. In a proof of concept case study we partnered with a project that developed a human biomonitoring mixture PBK model to calculate external exposure from biological samples. We accompanied the project from its instigation phase and made sure that our checklist was followed during execution and publication. We observed mutual impact: While the PBK model itself became significantly more suitable to be applied in regulatory environments, the feedback we received from the regulatory community also clearly showed that by exposing the checklist protocol together with the original research, visibility and consideration of the model were increased. We conclude that both parties can profit from a formal approach when bridging the gap between science and policy affairs.

### **P03.3320. Removing Outside Contamination from Individual Hair Strands for Use in Retrospective Exposure Assessments**

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Abstract: Analysis of bulk hair samples suggests that individual strands are suitable biomarkers of past exposures to metals such as Pb, Hg, and Mn. Laser ablation with inductively coupled plasma spectrometry (LA-ICPMS) allows compositional analysis of hair strands along their shaft. Outside contamination on a hair strand is difficult to remove with traditional washing procedures. We have developed a new method to address the issue of outside contamination. We coated two unwashed hair strands with epoxy and laser ablated three 40  $\mu\text{m}$  diameter holes (one at each end and one in the center) through the epoxy-encased hair. Ionized material was analyzed with ICP-MS for the 15 most common isotopes in hair (98% of typical hair composition). The created depth profiles were inspected for signal changes consistent with drilling through epoxy, drilling through hair, and drilling through epoxy again. Five isotopes ( $^{24}\text{Mg}$ ,  $^{55}\text{Mn}$ ,  $^{63}\text{Cu}$ ,  $^{66}\text{Zn}$ ,  $^{208}\text{Pb}$ ) showed similar response changes of at least five orders of magnitude, consistent with expected changes associated with drilling through epoxy and then transitioning from epoxy to hair, hair to epoxy, and passing through the core. The data suggests that (a) measurements taken inside and outside a hair strand can be separated, (b) a hair strand loses approximately 40% of its diameter over 12 months of growth, and (c) the concentration of an element in hair can be estimated using the total isotope counts and the counts of a metal of interest. Outside contamination can be identified when hair strands are analyzed with LA-ICPMS by using our approach of encasing individual hair strands with epoxy. Collecting the top 15 isotopes that encompass a typical hair strand allow calculation of the concentration of trace metals in hair. The substantial material loss of hair during its over time allows for signal composition and suggests further research to identify the maximum time period that hair can be used for retrospective exposure assessment.

### **P03.3330. Analysis of Urinary Biomarkers for Early-Life Exposure to Organophosphate Pesticides and Pyrethroids**

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**Abstract:** Organophosphate pesticides (OPs) and pyrethroids (PYRs) are widely used for pest control. Exposure to these chemicals has been linked to various negative health outcomes, particularly for young children. Urinary metabolites are commonly used biomarkers of exposure for non-persistent chemicals such as OPs and PYRs. A method is established for quantitatively measuring these biomarkers in human urine samples. Non-specific OP metabolites dialkylphosphates (DAPs; 6 compounds) are analysed using a lyophilisation method coupled with a subsequent derivatisation procedure using pentafluorobenzyl bromide. Samples are analysed using a gas chromatography coupled to triple quadrupole mass spectrometer. Other chemicals (13 compounds) are analysed via solid phase extraction using hydrophilic-lipophilic balance cartridges after hydrolysed by glucuronidase. Target compounds are analysed using liquid chromatography coupled to tandem mass spectrometry. Synthetic urine is prepared and used as blank samples. Method detection limit (MDL) is calculated as average of the levels in blank samples plus three times the standard deviation and ranges from 0.0083 to 0.83  $\mu\text{g L}^{-1}$  in urine depending on compounds. Quality control (QC) samples are prepared by fortifying the synthetic urine with target compounds. Accuracy of the method is evaluated as the ratio of calculated levels against expected levels and ranges from 0.68 - 1.4. Method precision is expressed as the relative standard deviation of calculated levels from replicated QC samples ( $n=15$ ) and is generally lower than 20%. The method is then applied to the analysis of 20 pooled urine samples from general Australian population, which are stratified into 5 age strata (0-1, 1-2, 2-3, 3-4, and 4-5 years) and two gender strata (2 $\times$ males and 2 $\times$ females). The highest mean concentration is measured for 3,5,6-trichloro-2-pyridinol (TCPy, 12  $\mu\text{g L}^{-1}$  urine). Significant trend of concentrations by age ( $P<0.05$ ) is observed for various OP and PYR metabolites.

### **P03.3340. High Flag Guidance Range Proposal for Urinary Inorganic Arsenic in the Canadian Population**

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**Abstract:** Background/Aim: A high flag is the concentration of a given biological marker above which a participant should be informed in writing of his/her exposure results and receive information and general advice to help determine, and if necessary control, the sources of exposure. The objective of this study was to propose a guidance biomonitoring value that could be used as a high flag for summed urinary inorganic arsenic species and their metabolites ( $\Sigma$ As), as measured in the Canadian Health Measure Survey. Methods: The starting premise of this work is that the Canadian maximum acceptable concentration (MAC) of 10  $\mu\text{g/L}$  for arsenic in drinking water corresponds to a level of exposure that should not be exceeded. Thus, the urinary  $\Sigma$ As concentration in a population consuming drinking water contaminated at the MAC, and exhibiting a background exposure level similar to what is observed in the Canadian population, was estimated. To do so, data describing the relationship between the urinary excretion of  $\Sigma$ As and the As content of drinking water were retrieved from a literature review. Due to the limited number of relevant studies ( $n=8$ ) and their related uncertainties, a range of significant values of interest was identified. Results: Individuals exposed to arsenic at the background level present in Canada and, additionally, to a water source contaminated at the Canadian MAC of 10  $\mu\text{g/L}$  would have, on average, a urinary  $\Sigma$ As concentration of between 7.5 and 13.3  $\mu\text{g/L}$ . These values are therefore proposed here as respectively the lower and upper limit of a high flag guidance range. Conclusions: This high flag range appears suitable to other population biomonitoring studies around the world in which the background exposure is comparable to the Canadian context. Before selecting a single value from within the proposed range, it will be important to assess the consequences that the determination of a threshold could have on the management and communication of the biomonitoring results.

**P03.3350. Toxic Metals, PFAS and PCBs in Blood and Urine Specimens Collected from New Jersey Clinical Laboratories and Blood Banks**

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**Abstract:** New Jersey (NJ) residents are disproportionately exposed to various hazardous chemicals due to the high density of industry, traffic, and commercial sources. Statewide biomonitoring data are needed to establish a baseline of exposure and to identify potential populations at risk. However, it is costly and laborious to implement a population-based sampling, such as the approach implemented by the National Health and Nutrition Examination Survey (NHANES) for general US population. NJ Department of Health (NJDOH) conducted biomonitoring for toxic metals, polychlorinated biphenyls (PCBs), and emerging pollutants perfluoroalkyl and polyfluoroalkyl substances (PFAS) using a cost-effective alternative approach, i.e. measure target contaminants in remnant specimens collected by clinical laboratories and blood banks in NJ. This project aims to assess the distribution of toxic metals in 3000 blood and 1000 urine specimens, PCBs and PFAS in 1000 sera for NJ adults (20-74 years old). From 2015 to 2017, the study has measured 3 toxic metals in 1760 blood specimens, 5 toxic metals in 218 urine specimens, 12 PFAS in 488 sera, and 40 PCBs in 220 sera. Preliminary data showed most analytes fell within the concentration ranges reported by NHANES. However, some pollutants, such as PFNA (GM [CI]=0.82 [0.78-0.85] NJ, 2016-2017 ng/mL), are elevated compared to the US general population (GM [CI]NHANES, 2013-2014=0.69[0.63-0.75] ng/mL); some surprisingly high results were observed for blood lead (e.g. 50.4 and 26.3 µg/dL) and mercury (several in the 20-30 µg/L range and one in 128 µg/L), and several PCBs showed higher levels than national averages. In-depth analyses are being conducted to examine whether body burdens of NJ adults are significantly higher than national levels and whether there are significant differences by age, gender, race/ethnicity, and geographic location. Through these analyses, NJDOH will identify potentially at-risk subpopulations for further exposure assessment.

**P03.3360. Unexpected, Ubiquitous Exposure in Brazil to Diisopentyl Phthalate, One of the Most Potent Antiandrogenic Phthalates**

Holger Koch

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Abstract: Human exposure to phthalates and other non-persistent chemicals in emerging market countries is largely unknown. A preliminary analysis of urine samples from pregnant Brazilian women indicated the presence of metabolites of Diisopentyl phthalate (DiPeP). Because of its chemical structure, DiPeP is probably located in the hot-spot of phthalate toxicity. In a rapid approach we tried to identify the origin of DiPeP exposure, reliably quantify specific DiPeP metabolites in human urine for exposure assessment and investigate the antiandrogenic potency of this phthalate in rats. We identified iso-amyl alcohol from sugar cane based ethanol production (fossil fuel replacement) as the feedstock for DiPeP production. We modified our phthalate method to include the primary DiPeP metabolite, monoisopentyl phthalate (MiPeP), and two oxidized metabolites (3OH-MiPeP and 4OH-MiPeP). We applied this method to a pilot pregnancy cohort from Curitiba, Brazil (50 urine samples from early pregnancy and 44 gestational pool samples). We could quantify DiPeP metabolites in nearly all (98%) of the early pregnancy and in all gestational pool samples with a median for MiPeP of 3.65 and 3.15 µg/L, respectively, and for the two oxidized metabolites between 1.00 and 1.70 µg/L. All urinary DiPeP metabolites were strongly correlated ( $r=0.89$  to  $0.99$ ). In a parallel approach, we orally exposed pregnant rats to DiPeP and Di-n-butyl phthalate (DnBP; reference phthalate) from gestation day 14 to 18 and measured ex vivo fetal testis testosterone production. We found the effective dose (mg/kg/day) inhibiting fetal testosterone production by 50% (ED50 [95% CI]) for DiPeP (93.6 [62.9-139.3]) to be significantly lower than for DnBP (220.3 [172.9-280.7]), confirming the strong antiandrogenic potency of DiPeP. The surprising and ubiquitous DiPeP exposure in Brazil sparks considerable concern and highlights the need to monitor also "uncommon" but toxic phthalates in worldwide population studies.

### **P03.3370. Toxicokinetic Modeling of Biomarkers of Exposure to Lambda-Cyhalothrin for Predicting Exposure and Determining Biological Reference Values**

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**Abstract:** A multi-compartment toxicokinetic model was developed to predict the time courses of the widely used pyrethroid lambda-cyhalothrin and its metabolites (CFMP and 3-PBA) in the human body and in accessible biological matrices following different exposure scenarios. Model parameters were determined using blood and urinary time course data of metabolites (CFMP and 3-PBA) in volunteers exposed to lambda-cyhalothrin by the oral and dermal routes. The modeling confirmed that the kinetics of biomarkers of exposure to lambda-cyhalothrin was similar to that of permethrin and cypermethrin metabolites. For the oral route, the model conceptual and functional representation is similar to the one previously developed by our team for permethrin and cypermethrin. However, representation of the dermal route has been improved to account for the metabolism of the pesticide in the skin by carboxylesterases. The model can be used to simulate single, multiple or continuous exposure scenarios, and multiple and/or simultaneous exposure pathways (oral, dermal or inhalation). Modeling was further used to derive biological reference values (BRVs) for the specific metabolite of lambda-cyhalothrin (CFMP) not to exceed to prevent health effects based on simulations of an exposure to the lambda-cyhalothrin reference dose values (RfD) established by the U.S. Environmental Protection Agency (0.0025 mg/kg bw/day for acute exposure and 0.001 mg/kg bw/day for chronic exposure). The BRV derived for an acute exposure scenario was 199 pmol/kg bw/day or 0.2 nmol/kg bw of CFMP in a 24 h urine collection, which corresponds to 0.9 µmol/mol creatinine. The BRV simulated for a chronic exposure scenario was 0.08 nmol/kg bw/day or 0.3 µmol/mol creatinine.

### **P03.3380. Method Validation for Analysis of Parabens and Antimicrobials in Human Hair**

Hyojong Park

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**Abstract:** Background/Aim Humans are constantly exposed to new chemicals. Among them, harmful substances are also included. EDCs affect human hormones and interfere with the endocrine system. Representative EDCs include parabens and antimicrobials. Samples of blood, serum, and urine are typically used to assessment of human exposure to EDCs. These samples are not adequate to reflect long-term exposure. Hair sample has been used for chronic and past exposure assessments in drug, doping and forensic studies. In this study, we investigate the possibility of biomonitoring through hair, and established pretreatment and analytical method for EDCs in hair. Methods A recovery test was conducted to establish six parabens and two antibacterial agents in hair. Hair samples (0.05g) were pretreated through LLE extraction with methanol (2mL), after added IS and STD. Quantitative analysis was performed using UPLC-MS/MS. Intra (n=7) and Inter (3day) validation were conducted to verify the validity of pretreatment and analytical method. Results As a result of the validation, accuracy were 34.4 ~ 110.4 % (inter) and 68.9 ~ 112.9 % (intra). Precision were 2.1 ~ 36.9 % (inter) and 2.1 ~ 21.7% (intra), and LOD were 0.108 (benzylparaben)~ 0.864(triclosan) ng/ml respectively. Conclusions EDCs biomonitoring by hair analysis will help us to overcome the difficulties in sampling from infants and long-term exposure assessment.

**P03.3390. Main Progress of the 3rd Stage Korean National Environmental Health Survey (2015-2017)**

Ji-Young Yoo

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**Abstract: Background/Aim** With the enactment of the Environment Health Act in 2008, the Korean National Environmental Health Survey(KoNEHS) has been repeatedly carried out since 2009. The KoNEHS is a nationwide biomonitoring survey and aims to monitor trends in exposure of Koreans to environmental chemicals. 32 environmental chemicals have been measured among 18,956 Koreans from the KoNEHS(2009-2017). **Methods** In the 3rd survey(2015-2017), we expanded the scope of target population to cover children(over 3 years old) and adolescents as well as adults. The sampling units for children and adolescents were stratified by area, school grade, and age, and 127 schools and 56 kindergartens and daycare centers were selected randomly. The sampling units for adults followed the same sampling strategy from the 1st and 2nd Surveys and 233 sampling units were selected. 26 environmental chemicals were measured in bio-samples of subjects. **Results** 6,167 subjects participated including 1,458 children, 922 adolescents and 3,787 adults. The proportion of males to females was 45.6% (2,815) to 54.4% (3,352), respectively. Urinary Bisphenol A concentrations decreased with increasing age. Urinary Bisphenol A levels in Korean adults tend to increase in the past 9 years whereas urinary phthalate metabolites levels tend to decrease. **Conclusions** Data collected from the past 9 years have been an important resource to figure out the environmental exposure and its effects on health. The representative levels of environmental chemicals has been announced as government-approved statistics. Based on the comprehensive evaluation of the 9-year study, the 4th Survey(2018-2020) has been planned and is underway.

### **P03.3400. LC-HRMS Biomarker Suspect Screening in Low Dose Studies**

Daniel Bury

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Abstract: Exposure biomarker development is a time consuming procedure, starting with identification of presumably appropriate metabolites of the xenobiotic in question. Investing into unsuitable biomarker candidates (i.e. metabolites which are formed in low proportion or are not formed at all) can be costly. Accordingly, efficient strategies for the identification of promising biomarker candidates are needed. For this purpose, liquid chromatography coupled with high resolution mass spectrometry (LC-HRMS) is often applied for metabolite screening in in vitro and animal in vivo screening approaches, typically involving high doses/concentrations of the xenobiotic. Given the limitations of in vitro models and interspecies differences in metabolism, we sought to improve the certainty of metabolite screening by analyzing urine samples from human studies with low oral dosing (i.e. toxicologically uncritical). Metabolite screening was performed by LC-Q-Orbitrap-MS combined with a commercial data mining software. Identification criteria were plausible excretion kinetics, product ion spectra, <sup>13</sup>C isotopomer ratios, and retention times. We present results of a pilot study, which identified nine metabolites of the plasticizer di (2-ethylhexyl) terephthalate (DEHTP). Three of them (5OH-MEHTP, 5Oxo-MEHTP, and 5cx-MEPTP) are already established biomarkers of DEHTP exposure. Five additional, specific metabolites have not been described previously. In another example we successfully identified several tentative metabolites of the UV filter avobenzene. However, we also report examples, in which metabolite identification did not succeed by this approach (e.g. the plasticizer DEHA) and we highlight influencing factors (such as mobile phase pH, in source adduct formation and fragmentation) possibly leading to wrong conclusions. The presented approach is a valuable but not universal tool for biomarker development. In some cases, a more sensitive triple quadrupole screening can be superior.

**P03.3410. Determinants of Xenoestrogen Exposure and Implications on Inter- and Intra-Variation of Urinary Biomarkers across Individuals**

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Abstract: Exposure to xenoestrogens such as parabens, bisphenols, triclosan and triclocarban is ubiquitous given their widespread use in consumer products. Spot urine samples provide a snapshot of chemical exposure concentrations at one point in time. The extent of variation exhibited by an individual in relation to the overall variability observed across a population is unclear. The objective of this study was to evaluate the exposure of healthy adults living in Western Massachusetts to a panel of xenoestrogens and investigate inter- and intra-individual variability as well as potential predictors of exposure. In this study we present results from an intensive biomonitoring campaign where morning (09:00) and evening (17:00) urine samples were collected from 10 participants over a 5-day period. Samples were prepared for analysis by liquid chromatography coupled with electrospray ionization tandem mass spectrometry (LC-ESI-MS/MS) using solid phase extraction. Concentrations of eight environmental xenoestrogens, including parabens (methyl-, ethyl-, propyl-, butyl-), bisphenol-A (BPA), bisphenol-S (BPS), triclosan and triclocarban were measured in urine in their unconjugated and conjugated forms. Hourly inventories of consumer and personal care product use, thermal paper handling as well as water and food consumption were also collected from participants. The association between these potential exposure factors and concentrations of xenoestrogens measured in urine were evaluated. Our optimized solid phase extraction procedure and MS/MS parameters achieved good sensitivity and recoveries ranging from 85 to 105%. Variability of creatinine adjusted paraben, BPA, BPS, triclosan and triclocarban concentrations in urine measured within and between individuals will be presented. Potential exposure sources will further be discussed.

### **P03.3420. Using the Comparative Toxicogenomics Database to Further Our Understanding of Environmental Exposures on Human Health**

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Abstract: The Comparative Toxicogenomics Database (CTD; <http://ctdbase.org>) is a freely available resource that promotes understanding about the mechanisms by which environmental exposures influence human health. Four categories of content are manually curated from the literature: toxicogenomics (chemical-gene interactions), diseases (chemical-disease and gene-disease associations), phenotypes (chemical-induced phenotypes), and exposure data (environmental stressor-receptor-event-outcome relationships). Exposure details, including stressor source, receptor age, sex, smoking status, biomarker levels, correlations with disease or phenotypes, and geographic location are also recorded. In our curation paradigm, controlled vocabularies, ontologies, mnemonic codes and structured notation are used to transform the literature into a semantic, computable structure, enabling integration among the four categories as well as with gene attributes, molecular pathways, species, and general toxicology information to provide a knowledgebase of over 36 million toxicogenomic relationships. These data can be explored with queries and analytical tools to inform hypothesis development connecting chemicals/drugs, genes/proteins, diseases/phenotypes, taxa, functional annotations, pathways, and population-based exposure events. In addition, they provide unique opportunities to generate predictive adverse outcome pathways (connecting chemical-protein molecular initiating events, key phenotype events, adverse diseases, and population-level health outcomes) as well as aggregate exposure pathways (relating real-world measurements of environmental stressors and biomarkers to demographics). CTD's centralization of exposure science data, integration with chemical-gene, disease and phenotype modules, and additional analysis tools provide a unique resource to advance our understanding of the molecular mechanisms of action by which environmental exposures affect human health.

### **P03.3450. Exposure to N,N-diethyl-m-toluamide (DEET) in the U.S. Population: 2007-2014**

Maria Ospina

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**Abstract:** Introduction: N,N-diethyl-m-toluamide (DEET) is the most widely used insect repellent in the USA with more than 500 DEET-containing products registered with the EPA. DEET is effective against disease-carrying vectors such as ticks and mosquitoes associated with Lyme disease, malaria, encephalitis, Dengue fever, West Nile, Chikungunya and Zika viruses. We have collected data from four National Health and Nutrition Examination Survey (NHANES) cycles (2007-2014) for urinary concentrations of DEET and two of its metabolites 3-(diethylcarbamoyl)benzoic acid (DCBA) and N,N-diethyl-3-hydroxymethylbenzamide (DHMB). Methods: We measured urinary concentrations of DEET and two of its metabolites in 10,362 Americans 6 years and older from the 2007-2014 NHANES. We used multiple regression to examine associations between concentrations of DCBA, the most detected DEET biomarker, throughout the years, and age, sex, race/ethnicity, and season of year. Results: DCBA was the most frequently detected biomarker (86%) with concentrations ranging from 0.33-382,000 µg/L; by contrast, DHMB was only detected in 14% (concentration range: 0.06-11,400 µg/L). For all age groups, DCBA adjusted geometric mean concentrations varied upon season of the year, being higher in summer than in winter. DCBA concentrations decreased significantly from 2007-2008 to 2013-2014 for samples collected during the winter months with the largest decrease observed among people older than 60 years of age. Conclusions: Exposure to DEET was prevalent in the general U.S. population in 2007-2014. Higher concentrations of DCBA, a reliable biomarker of exposure to DEET, in the warm season agree with increasing use of DEET when people usually spend time outdoors for recreational activities; also pests are more abundant with higher seasonal temperatures, and DEET can provide additional protection against vector borne diseases in warmer weather.

### **P03.3460. Prenatal Fluoride Exposure and Symptoms of Attention Deficit Hyperactivity Disorder (ADHD)**

Morteza Bashash

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**Abstract:** INTRODUCTION: Epidemiologic and animal-based studies have raised concerns about the potential neurotoxicity of fluoride exposure as manifested by deficits in IQ and problems with attention. To date, no prospective epidemiologic studies have examined the effects of prenatal fluoride exposure using fluoride biomarkers and sensitive measures of attention. OBJECTIVE: To test the association between prenatal fluoride exposure and symptoms associated with attention-deficit and hyperactivity disorder (ADHD) in 213 Mexican children aged 6-12 years old enrolled in the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) birth cohorts between 1997 to 2006. METHOD: We measured urinary fluoride levels during pregnancy and adjusted them for urinary creatinine (MUFcr). The Conners' Rating Scales-Revised (CPRS-R) was completed by mothers as a behavioural measure of attention problems, and the Conners' Continuous Performance Test (CPT-II) was administered to each child to assess sustained attention and inhibitory control. We used gamma regression analyses to examine associations between MUFcr and measures of attention, adjusting for covariates. RESULTS: The mean MUFcr level for all women was 0.85 mg/L (95% CI: 0.81, 0.90) and the Interquartile Range (IQR) was 0.46. In multivariate-adjusted models, a 0.5 mg/L increase in MUFcr (approximately IQR) corresponded to significantly higher CPRS-R scores for DSM-IV Inattention (2.84 points, 95% CI: 0.84, 4.84); Cognitive Problems and Inattention, (2.54 points, 95% CI: 0.44, 4.63), DSM-IV Total ADHD Index (2.38 points, 95% CI: 0.42, 4.34) and ADHD Index (2.47 points; 95% CI: 0.43, 4.50). The shape of the associations suggested a possible ceiling effect. No significant associations were found with outcomes on the CPT-II. Sensitivity analyses did not appreciably alter the results. CONCLUSION: Higher levels of prenatal fluoride exposure were associated with higher symptoms of ADHD measured by CPRS-R in the offspring at age 6-12 years.

### **P03.3470. Proteomic Array Analysis of an Epithelial Cell Model Infected with Cryptosporidium**

Eunice Varughese

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**Abstract:** Cryptosporidiosis is a human diarrheal disease caused by the etiological agent *Cryptosporidium*. This parasite abounds in the environment in resistant oocyst form and can cause life-threatening consequences in immunosuppressed individuals. By evaluating the fundamental mechanisms of pathogenesis in the host, it is helpful to deduce proteins involved in virulence. Parasite-induced host cell signaling events and subsequent cytoskeletal remodeling were investigated by using cultured human ileocecal carcinoma epithelial (HCT-8) cells inoculated with *C. parvum* sporozoites. Although many efforts have been made to characterize gene expression changes, these changes may not necessarily reflect changes in protein expression within an infected cell. New applications in proteomic arrays have the added benefit of studying changes in protein expression and functionality. In this study, we use a protein array platform to observe changes in protein expression and function when host cells are infected with *C. parvum* sporozoites. Previous studies have shown that the invasion of epithelial cells involves host-signaling whereby host cell actin reorganization allows for the enveloping of the parasite. A major signaling pathway implicated in actin polymerization involves the activation and deactivation of proteins containing SH2 domains, such as CRKL, PIK3, ABL, and the Src protein tyrosine kinase (PTK) family. Our studies show that a phospho-proteomic array of HCT-8 cells inoculated with the pathogen have a 0.87-fold increase in the phosphorylated form of c-Abl. Moreover, an SH2 proteomic array overlaid with protein lysates from uninfected and infected cells revealed that infected protein lysates had decreased binding (66%) to the SH2 domain of CRKL and increased binding (45%) to the SH2 domain of PIK3. These findings demonstrate a prominent role for proteins that may play a role in formation and stabilization of microvillar protrusions which envelope the pathogen.

**P03.3480. Distinct Fecal Microbiota and Serum Metabolite Profiles in Male Rat Exposed to Aluminum Oxide and Aluminum Oxide Nanoparticles**

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Abstract: The widely application of aluminum oxide nanoparticles (Al<sub>2</sub>O<sub>3</sub> NPs) in industry and personal care products has been raising concerns about their potential adverse consequences. However, the knowledge on their influence on gut microbiota and serum metabolism remains poorly understood. This study employed an integrated approach combining 16S rRNA gene sequencing and untargeted metabolomics profiling to investigate the impact of a 28 days oral exposure to  $\alpha$ - and  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> NPs and the equivalent dose of bulk Al<sub>2</sub>O<sub>3</sub> on the toxic response, fecal microbiota composition and serum metabolites of male rats. At the equal dose of 100 mg/kg bw,  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> NPs had a greater effect on white blood cell count, percent of monocytes, liver SOD activity and plasma GSH content, than that of  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> NPs and bulk Al<sub>2</sub>O<sub>3</sub>. 16S results revealed NPs exposure significantly perturbed the fecal microbiome composition, and the relative abundance of genus such as *Desulfovibrio*, *Steroidobacter* and *Acidibacter* was significantly reduced. A significantly lower alpha diversity and distinct microbial communities, as reflected by beta diversity, were observed in  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> NPs treatment, compared to bulk Al<sub>2</sub>O<sub>3</sub> and control. UHPLC-QTOFMS indicated that the circulating serum metabolites (e.g. 3-hydroxyisovaleric acid, dopamine, D-glucuronate) were significantly more abundant with  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> NPs, while metabolites (e.g. corticosterone, glycerol, glycerol 3-phosphate) were significantly induced by  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> NPs. Pathway analysis further indicated potential defects in the D-glutamine and D-glutamate metabolism and phenylalanine, tyrosine and tryptophan biosynthesis in  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> NPs, while glycerolipid and linoleic acid metabolism were significantly affected by  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> NPs. This study provides novel insights regarding the differential fecal microbiome and serum metabolome affected by nanoparticulate forms versus bulk forms of aluminum oxide in organisms.

**P03.3490. Factors Associated with Hair Nicotine Concentration: A Cross-Sectional Study in Children from Santiago, Chile**

Veronica Iglesias

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**Abstract:** Introduction: Exposure to secondhand tobacco smoke (SHS) is a world public health concern. Children are a vulnerable group. Accumulated exposure could increase health risks. The aim was to evaluate exposure to SHS in children measured through hair nicotine concentrations and its association with home air nicotine concentrations. Methods: Cross-sectional design study in schoolchildren between 6 and 8 y.old. A trained interviewer applied a standardized questionnaire to the mother, took the child's hair sample and placed a passive monitor in the living room to measure the indoor air nicotine concentration during 7 days. The association between air nicotine and hair nicotine was evaluated with logistic regression models. Results: 184 children were evaluated, 58.7% were female, 38.5% hair nicotine concentrations were above the limit of detection (LD) (0.058 ng/mg). When we measure air nicotine concentrations, 9.1% of the samples were above the limit of detection (0.026 ug/m3). We dichotomized both variables (over and below LD). Factors associated with detectable air nicotine concentrations were frequency of tobacco consumption (does not smoke (reference), some days OR=4.71; 95%CI 0.99-22.22, every day OR=12.62; 95%CI 3.25- 48.96); parental tobacco use within the household OR=13.68;95%CI 4,35- 43,11; parental tobacco use outside the home OR=5,46;95%CI 1,94-15,41. We found a significant association between hair nicotine concentrations and air nicotine concentrations after adjusting by age, sex and type of school (public/ private as proxy of socioeconomic level) (OR= 3.13; 95%CI 1.09-8.99). Conclusion: Considering that home is the main source of exposure, that children are exposed involuntarily and that there is human evidence linking SHS with cancer and other acute and chronic diseases, it is urgently needed to sensitize parents on the risks of exposure to SHS and to facilitate the adoption of preventive strategies such as smoke-free homes in the homes of smoking parents.

### **P03.3500. Enhanced Passive Surveillance Methods Using CDC and State Child Blood Lead Surveillance Data**

Tim Dignam

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Abstract: Local, state and national child blood lead level (BLL) surveillance is typically conducted passively. The increasing need to detect increases in the proportion of elevated child BLLs from surveillance data have highlighted the need for methods to detect and investigate changes of public health importance in a timely manner. Our objective was to develop and assess a modified Cumulative Summary (CUSUM)/Shewhart chart alerting algorithm for analysis of child BLL surveillance data that can be applied continually to improve the time to detect changes in reported BLL surveillance patterns. Geographic and temporal data-aggregation strategies were applied on routinely collected child BLL surveillance data employing an alerting algorithm using a sliding buffer concept. The algorithm accounts for long term trends, seasonal variation and serial autocorrelation of child BLLs. The algorithm was applied on 20 jurisdictions: two with a known increase in the proportion of children < 6 years of age with BLLs  $\geq 5$   $\mu\text{g}/\text{dL}$  and data from 18 randomly selected counties from the CDC Child Blood Lead Surveillance System. Alert signals retrospectively identified time periods in the two jurisdictions where a known increase occurred. No signals were identified among 17/18 (94.4%) randomly selected counties where no known changes occurred. The one county where a signal was identified appears appropriate to the data patterns, where a 67% decrease of children < 6 years of age tested occurred from the previous year. The algorithm accomplished adjustment for seasonality and de-trending. The modified algorithm provides a framework for enhanced passive surveillance by identifying changes in proportion of children w/ BLLs  $\geq 5$   $\mu\text{g}/\text{dL}$ . Algorithm settings are empirical and need to be set at the local level. The algorithm methodology needs replication at the local level. Further study is required to define alerting signal triggers when considering public health action compared with statistical significance.

### **P03.3510. Factors Associated with Low Level of Urinary Inorganic Arsenic Concentration**

Veronica Iglesias

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**Abstract:** Introduction: Population in Arica's city has been exposed to arsenic of natural and anthropogenic origin. In 2009, an environmental health center was created in order to surveillance exposure to polimetals, provide medical care to exposed population and propose intervention measures. Objective: To assess factors that predict the urine arsenic concentration in population served at the environmental health center in the period 2009-2015. Method: The population analyzed was recruited at the environmental health center of Arica, Chile between 2009 and 2015. The database provided included sociodemographic information, dwelling characteristics, urinary inorganic arsenic concentration and creatinine. We conduct linear regression analysis to assess association with variables included in final model. Results: Complete data was available for 10.437 people. The geometric mean of inorganic arsenic was 17.4 µg/L (min 1.99, max 477 µg/L). The variables that explained the urine inorganic arsenic concentration were urinary creatinine ( $\beta$  1.86 CI95% 1.82-1.91), alcohol consumption ( $\beta$  1.24 CI95% 1.00-1.53), drinking water consumption ( $\beta$  1.07 CI95% 1.04-1.11), the household material ( $\beta$  1.10 CI95% 1.03-1.17) and the soil discovered in yard ( $\beta$  1.01 CI95% 1.00-1.10). Conclusion: Although we identified variables that were significantly associated with urine arsenic concentration, they explain in a low proportion the arsenic variability. It is necessary to extend the study to identify variables that allow propose intervention measures to reduce exposure.

### **P03.3520. Shorter Gestation Is Associated with Renal Biomarkers at 4 Years**

Yuri Levin-Schwartz

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**Abstract:** Studies suggest that exposure to air pollution and heavy metals during pregnancy may contribute to birth outcomes such as shorter gestation. Since nephron development is not typically complete until 36 weeks of gestation, infants born prematurely may be more susceptible to renal dysfunction. Urine proteins reflect renal health and are predictive of kidney function later in life. We explored the association between gestational age (GA) and nine proteins in spot urine samples collected from 103 children aged 4-6 years participating in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) cohort in Mexico City. The nine urinary proteins: Albumin, neutrophil gelatinase-associated lipocalin (NGAL), osteopontin (OPN), kidney injury molecule-1 (KIM-1), clusterin, alpha-1-microglobulin, cystatin C, beta-2 microglobulin and trefoil factor 3, were selected based on their use as validated or emerging biomarkers of children's renal health and measured using the Luminex Milliplex System. We applied linear regression to examine associations between GA with individual proteins and used weighted quantile sum (WQS) regression, a statistical method developed to assess mixtures, to create a composite renal biomarker index of all 9 proteins. We adjusted for body mass index, indoor smoking, socio-economic status, age, gender, and urine creatinine. In the individual protein regressions, each day shorter gestation was associated with 12.9% higher KIM-1 (95% CI[-0.00, 24.00],  $p < 0.06$ ) and 4.4% higher cystatin C (95% CI[-0.33, 8.84],  $p < 0.08$ ). As is in the univariate models, the WQS renal biomarker index was associated with shorter gestation (-0.58; 95% CI[-10.09, -0.06],  $p < 0.03$ ). Weights constructed to parse the contribution of each protein to the result showed that albumin (24%), NGAL (19%), OPN (16%) and KIM-1 (16%) had the highest contribution. Motivated by these results, additional work will assess the interactions with environmental exposures.

### **P03.3530. LCMSMS Method to Analyze Metabolite of N-Methyl-2-Pyrrolidone (NMP) and N-Ethyl-2-Pyrrolidone (NEP) in Human Urine**

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Abstract: N-methyl-2-pyrrolidone (NMP) and N-ethyl-2-pyrrolidone (NEP) are shown to be embryotoxic and teratogenic.<sup>1-2</sup> These volatile solvents are widely used as industrial solvents in the manufacture of polymers, coating materials, paints, pesticides, cosmetics and pharmaceutical compounds.<sup>2</sup> And then, the population is very exposed. These compounds are quickly metabolised in 5-hydroxy-N-methyl-2-pyrrolidone (5-HNMP) and 5-hydroxy-N-ethyl-2-pyrrolidone (5-HNEP), follow by intermediate species, N-methyl-succinimide (MSI) and N-ethyl-succinimide (ESI). Finally 2-hydroxy-N-methyl-succinimide (2-HMSI) and 2-hydroxy-N-ethyl-succinimide (2-HESI) are produced (3) (4). Fast LCMSMS method based on dilute and shoot sample preparation has been developed and validated to measure the level of exposure after urine collection. A short study on 50 volunteers living in the Quebec City area allow to show that nearly 100% of the population was exposed to these solvents.

### P03. Risk Assessment and Policy 3

#### **P03.3540. The Exposure Science Aspects of the Re-Envisioning of the (U.S.) National Library of Medicine's Toxicology and Environmental Health Resources**

Pertti Hakkinen

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Abstract: The (U.S.) National library of Medicine (NLM) is a part of the National Institutes of Health (NIH). The NLM in early 2018 began an effort to re-envision its toxicology and environmental health resources. This is the first ever re-envisioning of these resources, covering several decades of existence for some resources. The goal is to optimize NLM's electronic resources in the areas of toxicology and environmental health by assessing and re-envisioning them to ensure that they continue to meet the changing needs of a diverse set of users. The overall coverage of NLM's resources includes chemicals and drugs, diseases and the environment, environmental health, exposure science, occupational safety and health, poisoning, emergency response, risk assessment and regulations, and toxicology. Examples of the users of NLM's toxicology and environmental health resources include academic researchers, government agencies, industry, not-for-profit organizations, and healthcare providers. A workshop of about 45 experts representing a wide range of these types of users was held in April 2018. The workshop provided in-depth insights into the information and services provided by NLM and what is foreseen for the future; It also identified current information sources (from NLM and elsewhere). In addition, it helped to identify critical gaps in the resources NLM offers in order to improve the function, content, and presentation of desired information resources in the future. Further, it provided in-depth insights to thoughtfully inform the development of a new generation of NLM resources. This presentation will focus on the exposure science-related aspects of this NLM re-envisioning effort.

### **P03.3570. Differential Inhalation Toxicity Induced by E-Cigarette Aerosol Flavorings in Association with Nicotine**

Seung-Hyun Cho

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**Abstract:** Significance. There is a significant need for data on respiratory effects of chemical constituents including flavorings in e-cigarettes (EC) aerosols to inform the regulatory science and communicate with the public about EC safety. Methods. Cytotoxicity and inflammatory response of human airway epithelial cells in a submerged culture were measured by MTT and immunoassay at 18 hours post-exposure to EC aerosols collected in an impinger. Aerosols were generated from an EC with heating coil power of 8.9 W using a program-controlled, customized smoking system following CRM No.81 and ISO puffing regimes. Four differently flavored e-liquids (i.e., non-flavor, menthol, sweet, tobacco) of 50:50 propylene glycol and vegetable glycerin with two nicotine concentrations (0% and 1.8%) for each flavor were tested in dose-response manner. Results. We found differential cytotoxicity and repressed immune response associated with flavorings. The menthol-flavored aerosols induced cytotoxicity in dose-response manner with 20% cytotoxicity at the highest dose as compared to the other two flavorings that showed 10% or less. Non-flavored aerosols showed little cytotoxicity that did not vary by dose and nicotine level, suggesting the vehicle and additives other than flavorings have little cytotoxicity for the condition we used to generate aerosols. Very low nicotine dose slightly improved cell viability, agreeing with previous reports in the literature. IL-8 production was reduced with increased dose, but not for menthol or sweet flavors. Conclusion. EC flavorings have a significant impact on the degree and variability of respiratory toxicity. Certain flavoring such as menthol together with nicotine would synergistically increase harmful effects in user's lung. More efforts that investigate the link between flavorings chemical composition in association with nicotine and respiratory health effects are needed to support regulation of harmful constituents in the EC products.

### **P03.3580. Cyanobacteria and Cyanotoxins in Sicilian Freshwater Basins (Italy): A Risk Assessment for Drinking Water**

Pietro Zuccarello

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Abstract: The eutrophication of surface waterways led to a rise in harmful cyanobacterial blooms worldwide. Sicily, the biggest Italian region, suffers from a strong drought and a growing scarcity of clean water. Toxin producing Cyanobacteria (CB) in Sicilian dams have been often reported, but they have not been regularly monitored until today. Therefore, health risk associated with cyanotoxins (CTX) in drinking waters remains largely unknown. To prevent urban water crisis in next future, we need to manage all water resources effectively, especially the more dynamic surface freshwater sources. Aim of this study was to monitor the major dams of Sicily used as drinking water supplies to carry out a risk assessment relative to the presence of CB and CTX in raw waters. Seven out of thirty-three Sicilian dams, used as drinking water supply, were monitored seasonally for one year. We collected samples of surface and deep waters. ELISA test was performed to detect sum of CTX microcystins (MCs) and nodularins (NOD). Also, for each sample, CB species were identified. *Planktothrix rubescens*, *Pseudoanabaena* sp., *Limnothrix redekei*, *Borzia* sp., *Merismopedia* sp., *Oscillatoria* sp., *Dolichospermum* sp. Picocyanobacteria were found in the studied basins. Sums of MCs and NOD were detected in each sample and their concentrations ranged between 2 ng/L and 669 ng/L. Presence of toxic CB (especially *P. rubescens*) in Sicilian lakes, whose waters are used for drinking purposes, could represent an important risk for human health. Variability of species in a same basin could lead to the selection of the most harmful one and to increase of MCs in drinking waters. In one year of monitoring we usually detected low concentrations of CTX, but in some cases they were close to the reference value that WHO assessed for drinking water (1 µg/L). Even if LC-MS and molecular confirmation are needed, our results suggest that a more regular and frequent surveillance is necessary to minimize risk for human health.

### **P03.3590. Regulation of Chemicals in Children's Products: How U.S. and EU Regulations Impact Smaller Markets**

Maya Negev

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**Abstract:** Background: Children's products may contain trace metals and organic compounds potentially harmful to children's health and development. Intergovernmental organizations and individual countries regulate chemicals in consumer products, but a coordinated international approach is lacking. Aim: To assess how a small market (Israel as a case study) is affected by the regulation of chemicals in children's products in large markets. Methods: We (1) compared regulations of chemicals in children's products in the US, EU and Israel; and (2) tested regulated and unregulated contaminants (trace metals, phthalates, bisphenol A and flame retardants) in six products categories (n=70) with potential for high oral/dermal exposure. Results: Due to the complexity of designing chemical regulation and to avoid trade barriers, Israel adopts product-specific standards that are fragments of complex regulations in large markets, whose impacts therefore extend beyond their territories. Thus, Israel has regulatory gaps because it lacks overarching legislation such as the EU REACH and the US CFR. For example, toys are regulated in Israel, while children's jewelry are not. We found 23% of jewelry samples exceeded the US standard for lead, while no toy samples exceeded the Israeli/EU standard for trace metals. In textiles, baby mattresses and diaper-changing mats, phthalates exceeded the EU standard in 21-45% of samples (mean, by mass: 6.74 % for diisononyl phthalate, 1.32 % for di(2-ethylhexyl) phthalate). Bisphenol A exceeded the EU standard in 14-45% of samples (mean 1.03 ppm). Discussion: While we found compliance with standards for products regulated in Israel, we also found high levels of chemical contamination, exceeding US/EU regulations, in unregulated products. By highlighting the impacts of the lack of a comprehensive regulatory framework, our results have advanced Israeli standards for children's jewelry and facilitated revisions of standards for mattresses and changing mats.

**P03.3600. Comparison of Dermal Exposure across a Diverse Range of Consumer Products Based on Modelling Approaches Commonly Applied to Human Health Risk Assessments under Canada's Chemicals Management Plan**

Cathy Campbell

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Abstract: Canada's Chemicals Management Plan (CMP) is an initiative aimed at reducing the risk posed by chemicals to Canadians and their environment. Since 2006, more than 3000 substances have been assessed in over 260 assessment reports and this work continues in the final phase of the CMP, including integration of novel and emerging approaches where appropriate. Many of the quantitative exposure assessments to date have included products available to consumers, including personal care, household cleaning, do-it-yourself (DIY) and paint products, with exposure characterization derived using modelling tools such as ConsExpo (e.g., for cleaning products, DIY and paint products) and in-house guidance (e.g., personal care products). This poster will present findings from an analysis where dermal exposures were compared and ranked for over 100 consumer products (including mixing/loading, application and post-application activities, as appropriate). The poster will include separate exposure estimates for specific age groups (toddlers, children, teenagers and adults) thus incorporating age-specific differences in amount applied, frequency of applications, and body weight. The results of this analysis can help to prioritize key sources of consumer exposures as well as identify subpopulation of interest over a wide range of uses. This poster will also provide a relative comparison of dermal exposure associated with products as diverse as cleaning products, DIY and personal care products and, where appropriate, may facilitate clustering or grouping of products with similar dermal exposure potential.

### **P03.3610. H2020 Insurance: Health Sector Demo**

Samya Pinheiro

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**Abstract:** Globally, there is increased concern about the potential impacts of extreme climate events, including their impact on loss and damage to people, assets and property. The Global Insurance Sector is a key actor to implement programs to improve resilience related to environmental risk factors such as the climate extreme events. The H2020 Insurance Project intends to operationalize a system, called the Oasis Loss Modelling Framework, which provides a standardized risk assessment process to assess potential losses, areas at most risk and quantify financial losses. The system will be implemented based on the application of demo for different sectors, including the HEALTH INSURANCE SECTOR. The objective is to help the health insurance sector to understand much more precisely the relation between the air quality, climate extremes and health conditions in a given population. The access to high-resolution data representing the systemic exposure to air pollution and climate extreme events must foster new innovations which will allow a better adaptation to new climatic conditions. Based on morbidity-mortality data and high-resolution environmental data, we will quantify the climate risk for vulnerable population groups and the health insurance sector in two different urban contexts (Berlin center and Potsdam) representing 2 typical European cities considering the period between 2005-2015. The focus in our showcase is on (urban) heat stress and air pollution affecting people with cardiopulmonary diseases, one of the most relevant impact pathways. In a second step, we will demonstrate how specific counteracting measures (establish ideal room temperatures, telemedicine to monitor the domestic environment, etc.) can help to reduce the impacts for vulnerable population groups and thereby to alleviate the costs, improve prevention, increase resilience and shorten recovery time.

### **P03.3620. Addressing Traffic Related Air Pollution: Local Public Health Challenges**

Emily Peterson

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Abstract: The growing body of evidence on the health impacts of traffic related air pollution (TRAP) exposures and the widespread population exposures to TRAP have clear implications for local public health practitioners. Vancouver Coastal Health (Vancouver, BC) has been exploring ways to reduce population exposures to TRAP within the major municipalities in its jurisdiction. This includes exploring the feasibility of setbacks for buildings that house vulnerable populations (daycares, long-term care, hospitals, and schools), and promoting the health impact assessment process to address TRAP and other transportation related health impacts. Throughout this exploratory work many hurdles have been encountered from defining "high" TRAP exposure areas for building setbacks to challenges with weighing the pros and cons of daycare siting. Our ongoing exploration of and approach to this complex challenge will be discussed. The Health Protection team within Vancouver Coastal Health includes both Environmental Health and Community Care Facilities Licensing (child care, long-term care). Within Environmental Health the Healthy Built Environment team works in collaboration with local governments to create environments that promote and protect health.

### **P03.3630. Regional Priorization of Contaminants of Interest in Environmental Health Based on Human Biomonitoring Data**

Michelle Gagné

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**Abstract:** BACKGROUND/AIM: Limited financial and human resources command to establish priorities in terms of environmental contaminants of public health interest. The objective of this work was to establish a regional list of priority chemicals based on the interpretation of a relevant subset of Canadian Human biomonitoring (HBM) data. METHODS: HBM data for Quebec's participants were extracted from the Canadian Health Measures Survey for 50 environmental pollutants. The priority determination was first made by comparing the geometric mean and 95th percentile biomarker concentrations of these data with the baseline levels of the Canadian population. Quebec's HBM data were then compared to Biomonitoring Equivalent, which are screening tools developed in a health risk assessment context. Using this second approach, chemical-specific hazard quotients (HQs) or cancer risk levels were generated for about ten compounds. RESULTS: The comparison between Quebec and Canadian HBM data allowed to identify 3 chemicals for which Quebec inhabitants biomarkers concentrations are deemed significantly greater than for Canadians in general, based on the non-overlapping of the 95% confidence intervals of the geometric mean. Using the second approach, the level of priority was determined as medium or high for 7 compounds (HQ values >0.1 or cancer risk of >10<sup>-6</sup>). Due to the limited number of compounds for which Quebec HBM data are currently available, the results of recent prioritization exercises based on Canadian and US HBM data and using BE complemented the present analysis. Overall, 24 substances of interest were identified in the present work. Cadmium, prioritized under the two approaches mentioned above, as well as arsenic, lead and acrylamide figure among those. CONCLUSION: The list of priority chemical built here can contribute to orientate public health actions in order to reduce population's exposure to critical environmental contaminants, or contribute to identify relevant research themes.

### **P03.3640. Multidisciplinary Approaches for the Assessment of Human Exposure to Organic Pollutants in the Indoor Environment**

Tunga Salthammer

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Abstract: Over time it became clear that exposure to chemical substances is complex in nature. We have come to understand that chemicals are distributed between the gas phase, airborne particles, settled dust and exposed surfaces, in a manner dependent on their respective physical properties. In terms of deposition and its effect, whether a molecule enters the lung via the gas phase or the particle phase makes a significant difference. The oral intake of substances from house dust is strongly dependent on the occupant's age and habit. The importance of the dermal intake pathway via the room air is now known and is the subject of several studies. Furthermore, we have also learned that secondary products from chemical reactions in the gas phase and on surfaces also contribute to exposure. Today, biomonitoring methods are available for many of the substances, which can be found in indoors. The identification of priority chemicals and the development of methods for these, with help from expert groups, is undoubtedly also a purposeful and seminal approach. With this contribution, which bases on a recent review paper, the authors hope to demonstrate that research addressing the sources, redistribution and fate of chemicals found indoors and human biomonitoring not only complement one another but also belong together within the field of exposure analysis. With the appropriate experimental design, external and internal exposure as well as the intake and uptake of a substance can be determined. A further important aspect is the post hoc analysis of house dust and urine samples, which are stored in environmental specimen banks. The identification and temporal tracking of so-called emerging chemicals is thereby enabled. This, in turn, creates the possibility of taking a virtual look into the future and acting preemptively, instead of constantly just looking back into the past and watching the decay of substances which have not been utilized for a considerable length of time.

### **P03.3650. Science and Policy of Fluorinated Surfactants in Firefighting Foam**

Tom Bruton

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**Abstract:** The use of aqueous film-forming foam (AFFF) in firefighting activities has resulted in the release of poly- and perfluoroalkyl substances (PFAS) to soil and groundwater in numerous locations, affecting the drinking water of millions in the U.S. Regulatory attention has focused on the subclass of PFAS known as long-chain perfluoroalkyl acids, including perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), due to their ubiquitous detection in the environment and their demonstrated hazard. For instance, U.S. EPA negotiated the phase-out of PFOS and PFOA with major manufacturers and issued drinking water health advisories for both substances. As firefighting foams containing long-chain PFAS have been phased out in the U.S., they have been replaced by formulations containing short-chain PFAS, despite the similar chemical properties of the two groups and the availability of PFAS-free alternatives. The widespread adoption of foams containing short-chain PFAS rather than fluorine-free foams was driven by a number of factors, some of which are scientific, others of which reflect the interests or values of different stakeholders. This presentation will compare and contrast the chemical and toxicological properties of long-chain and short-chain fluorinated surfactants used in AFFF, as well as the newer non-fluorinated alternatives. The presentation will also examine the environmental and firefighting performance criteria that resulted in the adoption of short-chain PFAS-based foams in the U.S. The evolution of firefighting foam use in the United States will be compared with that in other countries. Understanding the full context in which chemicals policy decisions such as this one are made can help scientists and policymakers find more effective solutions.

### **P03.3660. How Did Flint MI Happen**

Ronnie Levin

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Abstract: EPA's regulations to control lead contamination of drinking water are the most complicated of any of its drinking water regulations, and include source water analysis, identifying high risk sampling locations, sampling protocols that differ from all other drinking water sampling protocols, 50 times more samples, a different sampling regimen, and then treatment techniques, public education and even lead pipe removal. Nonetheless, media coverage of blatant violations of the US lead in drinking water rule repeatedly splay across newspapers throughout the country. The circumstances in Flint MI were the worst, but EPA's institutional tolerance of the widespread violations laid the foundation for what happened there. The very complexity of the lead rule provided the incentives and excuses for the 'gaming' that water utilities and their state overseers have used to avoid complying with the rule. It will only be through strengthened oversight and even public participation in monitoring that Americans will be protected against unnecessary lead contamination of public drinking water.

**P03.3670. Ambient Polycyclic Aromatic Hydrocarbons (PAHs) and Human Health Risks in Windsor, Canada and Detroit, U.S.A.**

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Abstract: Polycyclic aromatic hydrocarbons (PAHs) are toxic air pollutants with known adverse human health effects including cancer. A multi-year, high spatial density sampling campaign was carried out in two international border cities, Windsor, Ontario, Canada, and Detroit, Michigan, USA. The objectives were to 1) investigate the concentration levels and spatial distributions, 2) estimate incremental lifetime cancer risk (LCR) attributable to inhalation exposure of ambient PAHs, and 3) identify species and sources that are the major contributors to health risks. Air quality samplers were deployed for two two-week periods at approximately 50 sites in 2008 and 2009. Significant variability in concentrations, spatial distributions, and risk were observed between the two cities and between the two years. For individual PAH species and total PAHs, the concentrations were generally higher in Detroit than in Windsor and higher in 2009 than in 2008. Analysis of inter-species concentration ratios indicated both pyrogenic and petrogenic sources. Higher LCR levels were observed in Detroit than in Windsor in both years and were higher in 2009 than in 2008. The majority of the sites (74% in 2008 and 89% in 2009) registered LCR values above the 1 in 10<sup>6</sup> level, which implies that residents in both cities have the potential to be exposed to PAH related cancer risk at a non-inconsequential level defined by USEPA. Phenanthrene and anthracene combined account for more than 70% of the identified risks. This study provides unique perspectives on the spatial variability of ambient PAH concentrations, sources, and related health risks across two industrialized, urban cities that span an international border.

### **P03.3680. Evaluation of Health Symptoms and Air Exposures in Multiple Communities near Oil and Gas Operations in Colorado**

Allie Bamber

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Abstract: Unconventional oil and gas (OG) activity in Colorado is increasing in areas with large population growth. Community scale exposures to substances emitted from OG operations is a public health concern. The Colorado Department of Public Health and Environment (CDPHE) has received over 200 citizen reports of acute health symptoms and odors during the development phases of drilling, fracking, and flowback by people living near OG sites. In response to reports of citizen health symptoms, we have completed six community exposure investigations, resulting in over 800 hours of air samples for 64 OG related volatile organic compounds (VOCs) and select criteria air pollutants collected during different phases of OG operations. Investigations included 15 grab samples collected by either citizens or staff, downwind of the OG site during times of reported symptoms/odors in attempt to quantify maximum exposures. To capture continuous air measurements of VOCs and meteorological conditions over a longer time during different phases of operations, we deployed our mobile laboratory four times to two different communities. For each exposure investigation, we conducted screening level health risk evaluations to assess the potential for acute and chronic non-cancer and cancer health effects to occur to in those communities. For all community samples, all individual and combined VOCs had hazard quotients below 1 for non-cancer health effects and were within EPA's acceptable excess cancer risk range. Based on our evaluation of the continuous air monitoring, there is no clear evidence that airborne VOCs from OG operations result in potentially harmful long-term exposures to those living nearby. Although limited, our analysis of grab samples also suggests a low risk of harm from short-term acute exposures. More extensive site specific community level air monitoring is needed to fully understand the relationship between reported health symptoms and OG air exposures in Colorado.

### **P03.3690. Collective Intelligence and Skills Mobilization: The Key of the Outbreak in Trois-Rivières**

Caroline Marcoux-Huard

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Abstract: In July 2017, 7 cases of Legionnaires' Disease (LD) were declared to the Public Health Department. This was unusually high considering the region has an annual average of 5 declarations of LD. Also, address of residence of cases indicated they lived in a 7 km radius from each other. This spacio-temporal aggregate prompted an outbreak investigation. The infectious disease team questioned patients and family. Questionnaire revealed that all of them spent time outside, in Trois-Rivières (TR), Québec, Canada. As well, a few patients had everyday activities that were almost exclusively in the downtown area. At the beginning of the investigation, the environmental health team rapidly validated cooling tower's (CT) microbiological water quality. They were under the intervention threshold prescribed by the provincial regulations. Concomitantly, other potential sources of a Legionella were investigated in regards to their outbreak potential. The epidemiological survey highlighted the information on the temporal distribution of this outbreak (critical period between July 4th and 17th) and the concentration of patient's displacements in the city center of TR, confirming spatial distribution, which made it possible to refine environmental investigation. Therefore, culture results of a CT in this area were scrutinized in detail and irregularities were found. This CT had the results of recurrent interfering flora. Thus, the CT was resampled and results showed contamination at 630 000 CFU/l (under the current health standard of 1 000 000 CFU/l). Subsequently, the CT was closed. Ultimately, the Legionella strain found in respiratory specimen of the patients was a genotypic match to the one cultured from the CT and had never been documented in Quebec before. Major surveys require the participation of multiple skills from different horizons and use collective intelligence. This outbreak illustrates the complementary of the epidemiological and environmental investigations.

### **P03.3700. Incorporating Lifecycle Emission Information in Promoting Chemical Exposure Screening**

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Abstract: While high-throughput human chemical exposure screening often relies on hazard indicators such as persistence and bioaccumulation potential, realistic human chemical exposure and potential health risks are also dependent on factors such as chemical use information and chemical-specific exposure pathways. Multimedia, multi-pathway exposure models are being used for chemical prioritization and screening, the parameterization of which requires chemical specific use and emission information (e.g., how is it emitted? how much?). This information, however, is often insufficient or missing for most chemicals in commerce. To address this issue, we propose integrating substance flow analysis, which is a powerful tool to derive chemical emissions throughout the chemical/product lifecycle, into high-throughput screening for human exposure potential. As an illustrative example, we combine a substance flow model (a simplified version of CiP-CAFE) with chemical fate and exposure models (RAIDAR and RAIDAR-ICE), to create a modeling continuum from the quantity produced or imported to human aggregate exposure. Our model requires inputs of basic properties of chemicals (e.g., partitioning coefficients, and degradation/biotransformation rates) and associated products (e.g., use categories, lifespans and material characteristics). These properties can either be retrieved from existing data resources or calculated by models, which enables the model's wide applicability to high-throughput screening of both existing and new substances. The model allows "forward" evaluation of human aggregate exposure to chemicals arising from their actual use, or "back" calculation of the critical production/import quantities of a chemical that would not cause an unacceptable level of risk (the latter depends on the availability of toxicological data). Overall, the approach demonstrates promise in high-throughput exposure screening of the myriad of chemicals.

**P03.3720. Genetic Polymorphisms Are Associated with Body Burden of Metals, Persistent Organic Pollutants (POPs) and Omega-3 Fatty Acid Levels among Inuit of Nunavik Region in the Canadian Arctic**

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Abstract: Mercury (Hg), cadmium (Cd), lead (Pb), dichlorodiphenyldichloroethylene (DDE), and polychlorinated biphenyls (PCB-153) are potent toxicants of concern to the general public, and are in high concentration in some Arctic country foods. On the other hand, polyunsaturated omega-3 fatty acids [docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)] and selenium (Se) are vital nutrients found in marine diet. We hypothesize that single nucleotide polymorphisms (SNPs) in genes that mediate metabolism of toxicants and nutrients underline inter-individual differences in biomarker concentrations among a population living off local foods from aquatic and terrestrial ecosystems. Inuit members (n=665) from Nunavik (Quebec, Canada) were recruited in 2004 as part of the Qanuippitaa Survey. Blood samples were collected for quantifying toxicant (Hg, Cd, Pb, Se, DDE, PCB-153) and fatty acid (DHA, EPA) levels and genotyping (140 SNPs in genes relevant to toxicant or nutrient metabolism). Demographics were obtained from questionnaires. Here, we report results for 663 participants with complete genotype and biomarker datasets. ANOVA was used for statistical analysis. Mean (geometric) Hg, Cd, Se, Pb, DDE, PCB-153, DHA and EPA levels in blood were 11.07, 2.82, 301.2, 39.94, 2.92, 1.10 µg/L, 5.13 % / total fatty acid (TFA), and 1.31 % /TFA respectively. Out of 106 SNPs successfully genotyped, biomarker levels for Hg, Cd, Pb, Se, DDE, PCB-153, DHA, and EPA differed by genotype for 20, 11, 14, 1, 18, 23, 10 and 9 SNPs, respectively (ANOVA p<0.05). Only 13 SNPs (6 associated with Hg, 2 with Pb, 2 with DDE, 7 with PCB-153, 1 with DHA) remained significant following Bonferroni correction. The findings suggest that polymorphisms in environmentally-responsive genes can influence toxicants as well as nutrient biomarker levels. Hence, consideration of such gene-environment factors may improve the ability to assess the health risks and benefits of Arctic food more precisely.

**P03.3740. Key Exposure Models and Input Parameters Used for Assessing Exposure to Consumer Products Under Canada's Chemicals Management Plan**

Leona MacKinnon

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Abstract: Exposure models and associated input parameters are frequently used to estimate human exposure to chemicals in products available to consumers. The generation of intake estimates based on these models is often critical to assessing risks as mandated under Canada's Chemicals Management Plan (CMP). This poster presentation will highlight the impacts and challenges associated with using various exposure models based on the analysis of several published assessments conducted over the last decade. This includes a discussion on the rationale for the use of the models, and our tiered approach for refinements to exposure scenarios. The effects on the exposure estimates from modifying key parameters (e.g. mass transfer rate, product amount, and room volume) will be explored along with the presentation of case studies. Key similarities and differences between various consumer exposure models, including RIVM's ConsExpo, US EPA's Consumer Exposure Model (CEM), and Residential SOPs will be highlighted. This poster presentation showcases the decision making process when considering the models to use for characterizing exposure in assessments conducted under the CMP and exploratory work on new tools that can be used in future risk assessments.

### **P03.3750. Validation of the EAU Pharmaceuticals Workbook: Predicted Vs. Measured Environmental Concentrations**

Alison McLaughlin

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Abstract: The EAU pharmaceutical workbook can be used to calculate environmental concentrations of pharmaceutical ingredients. Two model scenarios are considered, one for consumer use and another for manufacture. For 48 pharmaceutical substances, the average predicted environmental concentration (PEC) from the model was compared to average measured environmental concentrations (MEC) in wastewater effluents. A difference ratio with a value of less than |10| represents a PEC within 1 magnitude of the MEC, while a difference ratio with a value of less than |100| represents a PEC within 2 magnitudes of the MEC. Results showed that 54.2 - 62.5% of predictions are within 1 magnitude of measured environmental concentrations, and 89.6 - 93.8% of predictions are within 2 magnitudes of measured environmental concentrations. The consumer scenario gave PEC values closer to the MECs than the manufacture scenario.

### **P03.3760. Evaluation of Potential Health Risk of 6:2 Fluorotelomer Alcohol (FTOH)**

Hien Le

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**Abstract:** Background Global fluorotelomer manufacturers have recently replaced the long-chain products with short-chain alternatives based on 6:2 fluorotelomer alcohol (FTOH) as a key raw material. FTOH is an intermediate used to manufacture polymeric water- and oil-repellent products, and its potential health risk has not been determined. Epidemiological studies regarding the human health effects of FTOH are not available. We conducted an exposure and risk assessment for FTOH. **Methods** Literature was reviewed and extracted for available FTOH environmental monitoring and toxicological data. Exposure assessment was conducted for inhalation, ingestion (dust and drinking water), and dermal routes of exposure in both general and occupational population. Exposures were estimated for different routes of exposures, applications, and populations using US Environmental Protection Agency Exposure Factors Handbook and CONSEXPO consumer product model. Human health risk assessment benchmarks were derived based on the available animal toxicity data and expressed as a risk characterization ratio (RCR). **Results** Inhalation and oral ingestion of dust are the most significant routes of exposure among adults (general and worker) and children, respectively. The RCRs based on conservative exposure estimates were <1 for all routes of exposures in both adults and children. An RCR <1 is an indication of no increase in health risk based on the derived human health risk assessment benchmarks of FTOH. **Discussion** While there is considerable published FTOH monitoring data, there has been no evaluation of health risk even though there is sufficient published animal toxicity data to do so. In order to evaluate risk, a comparison of exposure to hazard is required. This is an important part of evaluating health risk and prioritizing actions. Based on the conservative exposure assessments used in this evaluation, the current reported exposure levels of FTOH do not indicate an increase in human health risk.

**P03.3780. Ecohealth and Medical Geology Approaches as Integrative Methodological Tools to Address Environmental Lead or Arsenic Exposures and Health Issues in Uruguay**

Nelly Mañay

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Abstract: Environmental public health issues have many interactions between social and environmental determinants so there is a need to combine exposure and health assessments. Then, contributions and knowledge integration of academics and stakeholders, focusing on transdisciplinary local and regional actions with a global perspective are required to address these new challenges. Ecohealth and Medical Geology approaches are invaluable methodological tools to apply in environmental health risks evaluations and to take transdisciplinary actions for communities health quality improvement on a regional and global scale. This work aims a retrospective outlook and experience gained of how these methodological approaches were applied in Uruguay to health issues studies and policies, due to urban lead contamination and arsenic levels in groundwater. Ecohealth approach has been very useful for lead contamination studies and population awareness as environmental management, health care, economic factors and demands or complains from the community were considered, of equal importance. Medical Geology has given a methodological framework of an interdisciplinary scientific field that integrates geosciences, and health sciences. Baseline studies on arsenic levels in groundwater and associated health risks are being developed with this approach, to improve public health prevention. The experience of applying these methodological approaches in Uruguay, has resulted in developing locally integrated research tools to understand how to link chemical environmental exposure and health impacts assessment, with the participation of the affected community, stakeholders and policy makers. In conclusion, Medical Geology and Ecohealth approaches are related and can improve understanding health impacts from geoenvironmental factors and ecosystems, integrating multidisciplinary knowledge and transdisciplinary thinking to give solutions of what can be done to minimize or prevent environmental health risks

### **P03.3790. Standard Rodent Housing Conditions Produce Significant and Sustained Levels of Particulate Matter**

Ben Nephew

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Abstract: While the mass of airborne particulate matter have established health guidelines for humans, similar recommendations are not available for laboratory rodent cages. Several studies have assessed the airborne contaminants produced by laboratory animals at the macroenvironment room level to reduce occupational health hazards for those working in animal facilities. These studies have led to established guidelines for protocols such as frequency of cage changes, animal room ventilation rates, and frequency of animal room air changes. However, microenvironmental cage measurements can differ greatly from the macroenvironmental room measurements. Cage-level particulate matter studies are needed to ensure that the laboratory rodent microenvironment is not having a detrimental effect on animal welfare and validity and relevance of scientific data. The objective of the current study was to assess PM levels produced by common rodent bedding types in bar lid and filter top covered rat cages. PM levels were assessed following artificial manipulation of the bedding (designed to simulate typical rodent activity) and during an hour of activity by two adult rats following a standard cage change using pine, aspen, paper, and corn cob bedding. Simulated activity and rat induced disruption of all types of bedding produced significant and substantial increases in PM (1000-6000  $\mu\text{g}/\text{m}^3$  PM<sub>2.5</sub>), with elevated levels ( $>50\mu\text{g}/\text{m}^3$ ) sustained for longer durations in cages with filter tops (5-6 minutes) compared to cages with only bar lids (0-2 minutes). These results indicate that standard laboratory housing conditions produce differentially substantial levels of PM that are likely to impact animal welfare and/or experimental data in animal studies of PM exposure.

**P03.3800. Nutritional Interventions for Childhood Lead Exposure: The Need for More Consistent Public Health Messaging across the International Community**

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Abstract: Childhood blood lead levels (BLLs) have been decreasing over the last few decades due to various policies countries have adopted that were helpful in reducing sources of exposure and by providing appropriate public health messaging surrounding the science. Despite this decrease in BLLs, many children across the globe are still exposed to a variety of lead sources including those from paint, battery recycling facilities and mining activities, and have associated health impacts. Public health messaging surrounding appropriate nutritional interventions for children exposed to lead are misleading for parents and caregivers, and should be enhanced to provide the public with more consistent messaging surrounding up-to-date science. An assessment of the literature using PubMed was conducted to examine the availability of international epidemiological studies on the association between children with elevated BLLs and nutrient intake. Furthermore, a review of nutritional interventions by various health agencies was examined to understand specific language provided to parents for children with elevated BLLs. Unfortunately, messaging regarding nutritional interventions and childhood lead exposure is not always backed by the most current scientific data. Additionally, outreach materials are either nonexistent or varied across the international community, creating very inconsistent messages for parents and caregivers. While some data exists to support a connection between good nutrition and mitigation of lead absorption, there is lack of evidence that supports a connection between nutrient consumption and removal of lead in the body, which should be clearly distinguished in outreach materials. To ensure appropriate delivery of accurate messaging surrounding nutritional interventions for childhood lead exposure across the globe, an international effort to improve messaging surrounding appropriate nutritional interventions for children exposed to lead should be considered.

### **P03.3810. PFAS in the Drinking Water: A Swedish Register Study of Thyroid Disease**

Eva Andersson

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**Abstract:** Background In Ronneby, Sweden, the use of fire fighting foam at a military airfield has resulted in the leakage of perfluorinated substances (PFAS) into the drinking water for part of the population. A population sample from Ronneby had median serum levels of PFOS, PFHxS and PFOA of 176, 152 and 10 ng/ml respectively. Materials and methods All individuals who ever lived in Ronneby municipality during 1980-2013 were included in the cohort. Each household was supplied by water from one of two waterworks, one of which was contaminated. A time-varying exposure was assessed, and exposure was classified into "never", "early" (1985-1994), "mid" (1995-2004) and "late" (2005-2013). Information from i) the National Patient Registers (on disease diagnosis), ii) the cause-of-death register and iii) the Prescribed Drug Register was linked through the personal identity number. Diagnosed cases of hypo- or hyper-thyroidism were identified from 1985 and on, and the corresponding medications from 2006 and on. Time to first diagnosis or prescription was analysed using a Cox proportional hazards model (age on the time axis, separate baselines for the three time periods). Results Approximately one third of the cohort (33800 men, 30396 women) had been exposed. For hyper-thyroidism diagnoses, the hazard ratios (HR) showed no significant increase, either for men or women. For hypo-thyroidism diagnoses, the HR was elevated among men (HR=1.36,  $p<0.05$ ), but no increased HR was seen in the prescription data. For women there was no significantly increase risk, either for diagnosis or prescription. Conclusion the register study gives no strong evidence for an increased risk of hyper- or hypo-thyroidism for individuals living at addresses with PFAS contaminated water in Ronneby, Sweden.

**P03.3820. More Than a Technical Challenge: The Social Life of Cumulative Risk and Mixtures Toxicity Policy**

Devon Payne-Sturges

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Abstract: It is widely recognized that Americans are exposed daily to multiple chemical compounds in our air, food, water, and consumer products, and that many low income and racial and ethnic minority populations bear a disproportionate share of these exposures. Significant research investments have been made to develop methods to assess the combined effects of multiple chemical exposures, and literature on the cumulative health effects of joint exposure to chemical and social stressors is growing. However, little progress has been made to advance federal and state policy responses to scientific findings about cumulative impacts and risk. We are conducting two studies, leveraging contributions from multiple disciplines, to explore the challenges related to advancing policies to reduce cumulative human health risks and impact at the U.S. Environmental Protection Agency and in the state of Maryland. Through science policy archival research and content analysis, ethnographic research methods, and policy analysis, we examine the scientific, social, and political framings of cumulative impacts and risk, and how they are understood and acted upon by legislators, environmental and public health agencies, business leaders, advocates, and other key stakeholders. Preliminary findings indicate three themes that emerge as barriers to the advancement of cumulative risk governance, policy, and regulatory decision making: concepts and terminology ("cumulative impacts" vs "cumulative risk"), issues of social justice, and ownership and responsibility. Understanding and overcoming these barriers are critical in order for decision makers to effectively address cumulative risks and impact of multiple chemical and social stressors

### **P03.3840. Data Evaluation Criteria for Exposure Studies**

Nathan Mottl

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Abstract: On June 22, 2016, the Frank R. Lautenberg Chemical Safety for the 21st Century Act was signed into law thereby amending the Toxic Substance Control Act (TSCA), the Nation's primary chemicals management law. The amended TSCA requires EPA to make science decisions that are consistent with the best available science and the weight of the scientific evidence. The science standards must be implemented in both the hazard and exposure assessments of the TSCA risk evaluation to ensure that the underlying science is reliable and unbiased. To meet the standards, EPA developed criteria to assess the quality of multiple data types (i.e., monitoring data, modeling data, survey-based, epidemiology, experimental, database, etc.) supporting the exposure assessment. The criteria will be applied to the relevant data sources that were identified through a systematic search and met the inclusion criteria during screening and evaluation. Evaluation criteria are intended to assess the reliability, representativeness, accessibility/clarity, variability, and uncertainty of the data. This presentation will primarily focus on describing the evaluation strategy, including criteria, that EPA developed to assess the quality of the different types of exposure data. EPA is developing the data evaluation process during the analysis phase of risk evaluation. It will also identify potential issues encountered during the process as part of designing and executing systematic review approaches and methods to meet TSCA science standards. The views expressed in this abstract are those of the authors and do not represent Agency policy or endorsement.

### **P03.3850. General Factors of the Korean Child-Specific Exposure Factors**

Wonho Yang

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**Abstract:** Background/Aim Exposures among children are expected to be different from exposures among adults, because of physiological and behavioural differences. Children may be more exposed to some environmental agents because they consume more of certain foods and water per unit of body weight and have a higher ratio of body surface area to volume than adults. The purpose of this study was to produce the general factors of Korean child-specific exposure factors. Methods The general factors including body weight, body surface area, inhalation rate, intake of drinking water and food, and time-activity pattern of Korean children aged 0 to 18 years were investigated. The produced recommended values of general factors were compared with other countries. Results Long-term inhalation rates in male and female were 13.64 m<sup>3</sup>/day and 11.78 m<sup>3</sup>/day, respectively. And short-term inhalation rates of resting, slow walking (light exercise), and slow running in male were 0.55 m<sup>3</sup>/hr, 1.084 m<sup>3</sup>/hr, and 1.368 m<sup>3</sup>/hr, respectively. 93.02% (18.44 h) for a day was spent in indoors on average, considering weekday and weekend day together. The most time (18.44 h, 76.83%) was spent in residential indoor. The times spent in schools or kindergartens (nurseries) and other indoors were 2.66 h (11.09%) and 1.21 h (5.09%), respectively. The time spent in outdoors and transports was 0.81 h (3.36%) and 0.87 h (3.61%), respectively. Hand-to-mouth and object-to-mouth frequencies (contact/hr) aged 1 to 6 years were 4.80 contacts/hr and 3.26 contacts/hr, respectively. Conclusions This study was carried out for the first time in Korea. Risk assessment considers the situations and characteristics of the exposure environment and host. Various physiological variables of the human body reflects the characteristics of the children that can directly influence risk exposure. Therefore, identification of exposure factors based on the Korean children is required for appropriate risk assessment.

### **P03.3860. Regulating Chemical Exposures: Using Legal Epidemiology to Determine Enforceable PFAS Standards**

Jennifer Black

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Abstract: PFAS is a large family of man-made chemicals present in stain-resistant, waterproof, and non-stick consumer products. PFAS accumulates in biological tissues and does not break down when exposed to natural elements like air, wind, or water. They can also travel long distances through the air, meaning that exposures can occur beyond where PFAS is manufactured. Exposure can lead to health concerns such as kidney and liver issues, immune disorders, and decreased response to vaccinations. Some of these chemicals are also known to spread to fetuses in cord blood and to newborns through breast milk. PFAS are currently not subject to the national primary drinking water regulations under the Safe Drinking Water Act. Instead, EPA develops Health Advisories (HAs) for them, which are not legally enforceable and only serve as technical guidance. Therefore, states must regulate these chemicals to have any enforcement ability. Researchers sought to identify states with legally-enforceable PFAS requirements and policies related to PFAS. Using legal epidemiology methods, legal researchers assessed PFAS laws and policies across the 50 states and DC. Researchers developed coding questions to account for the content of the laws, such as exposure limits in each state and which mediums were regulated (i.e. water, air, soil). This presentation will describe how state and local health and environmental departments can use this information to inform their own laws and prevent exposure to harmful chemicals.

### **P03.3870. Challenges in the Application of Systematic Review Methods for Environmental Hazard Identification: Lessons Learned and Future Considerations**

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**Abstract:** Systematic review methods aim to increase transparency, rigor, and reproducibility of literature-based evaluations, for the purposes of reaching a weight-of-evidence conclusion. These methods are becoming a gold-standard for reaching hazard conclusions for environmental exposures. They also have broad policy implications, and are being used by governmental bodies in public health decision-making. However, many of these methods were created with the evaluation of clinical studies in mind. Key differences exist when applying systematic review methods intended for evaluating the effectiveness of a clinical intervention to environmental studies. Unlike clinical trials, environmental and occupational exposure studies have greater variability in their study designs, populations and exposures. Steps in the systematic review process - literature searching, publication selection, and study quality evaluations- are more complex, labor-intensive, and prone to human error. Significant manpower and scientific expertise is needed to produce a quality evaluation. We describe the application of systematic review process for evaluating observational studies in environmental health. For example, the U.S. Report on Carcinogens has applied these methods to six cancer hazard assessments (e.g., trichloroethylene, light at night/shift work). New and existing systematic review tools have been developed specifically for environmental health to aid in the process. An overview of tools for literature searching, systematic data extraction, risk of bias (i.e., study quality) and sensitivity evaluations, and meta-analyses will be discussed. We also offer considerations for the utility of these tools including the development of novel automation techniques in relation to the purpose and quality of a review. Lastly, we propose future steps to improve methods and utilize new techniques to improve causal inference.

### **P03.3880. Students' Environmental Risk Perception in University of Catania (South Italy): Results of a Cross-Sectional Study**

Maria Fiore

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**Abstract:** Introduction: Risk perception is associated to different socio-cultural and individual factors, like subjective judgment and level of Health literacy (HL), which are poorly studied in Italy. This study has investigated students' environmental risk perception related to the level of HL. Methods: Enrolment was carried out in scientific-health and humanistic-legal-social sectors in the University of Catania. The students filled out a structured questionnaire in three sections that explore socio-demographic, environmental risk perception and HL data. The HL was calculated by assigning a score of 1 to each correct answer and calculating their mean. The mean values were divided into two categories: poor vs good ( $\leq 9$  vs  $> 9$ ). A risk perception score was calculated by summing up the item ratings. Collected data was stratified by HL. A logistic regression model was used to identify possible factors associated with a low environmental risk. Significance was set at  $p \leq 0.05$ . Results: We enrolled 574 students (365 females, 209 males), aged between 18 and 44, 320 of whom attending scientific-health sector and 254 humanistic-legal-social sector respectively. At the logistic regression analysis the students with a low environmental risk perception resulted to be affected by almost a threefold risk of getting away from high HL (OR = 2.96; CI 95% 1.16-7.54). HL was influenced by students' age ( $<21$  vs  $>22$ ; p-value= 0,000), the sectors (scientific-health vs humanistic-legal-social sectors) and duration of the study course (three vs six years; p-value 0,000). Conclusions: Our results highlight that focus on HL might improve students' environmental risk perception which may bring positive impact on making decisions, planning and implementing strategies.

### **P03.3920. Use of Twitter Data to Improve Zika Virus Surveillance in the United States during the 2016 Epidemic**

Jun Wu

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Abstract: Zika virus (ZIKV) is an emerging mosquito-borne arbovirus that can produce serious public health consequences. In 2016, ZIKV caused an epidemic in many countries around the world, including the United States. ZIKV surveillance and vector control is essential to combating future epidemics. However, challenges relating to the timely publication of case reports significantly limit the effectiveness of current surveillance methods. In many countries with poor infrastructure, established systems for case reporting often do not exist. Previous studies investigating the H1N1 pandemic, general influenza and the recent Ebola outbreak have demonstrated that time- and geo-tagged Twitter data, which is immediately available, can be utilized to overcome these limitations. In this study, we employed a recently developed system called Cloudberry to filter a random sample of Twitter data to investigate the feasibility of using such data for ZIKV epidemic tracking on a national and state (Florida) level. Two auto-regressive models were calibrated using weekly ZIKV case counts and zika tweets in order to estimate weekly ZIKV cases one week in advance. A comparison of predicted versus observed weekly ZIKV case counts following model calibration demonstrated overall good predictive accuracy, with an R<sup>2</sup> of 0.74 for the Florida model and 0.70 for the U.S. model. Time-series analysis of predicted and observed ZIKV cases following internal cross-validation exhibited very similar patterns, demonstrating good model performance. Spatially, the distribution of cumulative ZIKV case counts (local- & travel-related) and zika tweets across all 50 U.S. states showed a high correlation ( $r = 0.73$ ) after adjusting for population. This study demonstrates the value of utilizing Twitter data for the purposes of disease surveillance, which is of high value to epidemiologist and public health officials charged with protecting the public during future outbreaks.

### **P03.3930. Green Spaces and Self-Satisfaction and Social Contacts in Adolescents: The Caspian-V Study**

Sanam Hariri

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**Abstract:** Introduction: A growing body of evidence has associated contact with green spaces with improved mental health and wellbeing in adults. Few studies have also suggested social contact as a potential mechanism underlying health effects of green spaces. The aim of this study was to evaluate the association of the use of green spaces with self-satisfaction and social contact in adolescents. Towards this aim, it also disentangled the associations for different types of green spaces, evaluated the modification of these associations by socioeconomic status (SES), level of urbanity, and sex, and investigated the mediator role of social contact in the association between use of green spaces and self-satisfaction. Methods: Data were obtained through valid questionnaires from a population-representative sample of 10,856 adolescents (10 to 18 years old) living in urban and rural districts across Iran who participated in the fifth survey of a national school-based surveillance program (CASPIAN-V). Logistic mixed effects models with recruitment centre as the random effect were developed to estimate associations adjusted for relevant covariates. Results: More time spent in green spaces was associated with improved self-satisfaction and social contact. While for the self-satisfaction association, we did not observe any indication for effect modification by sex, SES, and urbanity, there were some suggestions for stronger associations for social contacts for boys and those residing in rural areas or from lower SES groups. Social contact could explain more than half of the association between green space use and self-satisfaction. Conclusions: Longer time spent in green spaces was associated with enhanced self-satisfaction and social contact. Social contact could possibly act as a mediator for the association between green space use and self-satisfaction. Further longitudinal studies are required to replicate our findings in other populations with different cultures and lifestyle habits.

### P03. Occupational Issues 3

#### **P03.3940. Lived Experiences of Heat Exposure as an Occupational Safety Hazard in Australia**

Alana Hansen

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**Abstract:** Workers exposed to hot environmental conditions can be at heightened risk of heat-induced illnesses and injuries. With hot days becoming more frequent in Australia, heat exposure is gaining importance as a major health and safety issue for workplaces. The aim of this study was to use a qualitative approach to better understand how heat exposure can lead to occupational injury in order to inform prevention measures. Twenty one semi-structured interviews were conducted across five Australian states with people who had direct experience or knowledge of hot outdoor or indoor work environments. The participants, aged between 23 and 68 years, spoke about heat-associated hazards in industries including construction, mining, manufacturing, transport, emergency services and agriculture. Participants recounted occupational heat-related illnesses and injuries, ranging from minor to permanently disabling, and in some cases, fatal. Often there were confounding and contributing factors as well as heat strain which led to actual or potential adverse outcomes. Those affected included experienced, acclimatised and healthy workers in both indoor and outdoor environments. Migrant workers under visa conditions were identified as a particularly vulnerable subgroup in terms of both working conditions and predisposing living conditions. Recommendations from interviewees included more training and awareness for individuals, co-workers and supervisors. Overall, the participants' diverse narratives highlighted a range of heat exposures leading to compromised occupational health and safety, and the difficulties associated with formulating guidelines and effective preventive measures to suit all work situations.

### **P03.3950. Heat Exposure, Volume Status, and Kidney Tubular Injury in Washington Crop Workers**

June Spector

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**Abstract:** Objective: Acute kidney injury has been observed in US agricultural workers, and repeated dehydration in the setting of heavy physical work may contribute to the global problem of chronic kidney disease of unknown etiology (CKDu). We sought to assess the relationship between personal ambient heat exposure and biomarkers of early kidney injury in Washington (WA) tree fruit harvesters. Methods: Forty-five harvesters participated in a cross-sectional study during the summer of 2015. Heat exposure was assessed as the maximum work-shift wet bulb globe temperature (WBGT) measured near each participant, and kidney outcomes were assessed using urine tubular biomarkers ( $\beta$ 2 microglobulin, N-acetyl-B-D-glucosaminidase [NAG]). Pre/post-shift urine specific gravity (USG) was measured to assess volume status. Pre- and post-shift biomarkers were compared using paired Student's t-tests. Associations between maximum WBGT and post work-shift biomarkers were evaluated using mixed effects models, adjusted for relevant confounders. Results: Mean (sd) pre-shift USG (1.025 [0.007]) indicated mild dehydration. Workers whose USG changed from  $\geq 1.025$  pre-shift to  $< 1.025$  post-shift (n=8) exhibited a decrease in mean NAG normalized to USG (5.7 (1.2) to 3.9 (1.5) U/L;  $t[7]=5.24$ ,  $p=0.04$ ), but results were different for urine  $\beta$ 2 microglobulin outcomes, which can be affected by diurnal variation, and when normalizing biomarkers using urine creatinine. There was no significant relationship between maximum WBGT and post-shift urine  $\beta$ 2 microglobulin and NAG. Conclusion: Optimizing volume status both pre-shift and during the work-shift may help prevent adverse kidney effects in workers laboring in the heat. Selection and analysis of biomarkers of early tubular injury should include consideration of: 1) diurnal variation over the course of the day; 2) normalization approaches, as adjustment of biomarkers using urine creatinine may be problematic in populations performing physical exertion.

### **P03.3960. Prevalence and Risk Factors of Chronic Kidney Disease among Workers in the Brick Making Industry of La Paz Centro, Nicaragua**

Madeleine Scammell

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**Abstract:** In Central America there is an epidemic of chronic kidney disease (CKD) of non-traditional etiology. Few studies have assessed CKD prevalence among non-agricultural workers. We conducted an observational study of 224 artisanal brick workers in La Paz Centro, Nicaragua. Prevalence was based on serum creatinine measures at two time points four months apart. Predictors examined include: Age, sex, education, smoking status, body mass index, alcohol consumption, water consumption, family history of CKD, years worked, hours worked, job category, and time (baseline vs. follow-up). Outcomes included serum creatinine-based estimated glomerular filtration rate (eGFR) and stage of CKD. Results indicate CKD prevalence of 14.3% based on the proportion of participants with eGFR < 60 ml/min/1.73m<sup>2</sup> at both time points; 97% of cases were male, 25% were less than 35 years of age, and 28% had stage 5 CKD (eGFR <15 ml/min/1.73m<sup>2</sup>.) Predictors identified by linear mixed effects models included a job task that entails loading or operating the oven, age, sex, education, smoking status, water intake, and family member with CKD. Limitations of this study include a crude job classification metric, loss to follow-up, small sample size, self-reported questionnaire data, and no quantification of albuminuria. According to NHANES 2011-2014 data, estimates of US prevalence ages 20-39 and 40-59 with eGFR <60 ml/min/1.73m<sup>2</sup> were 0.3% and 3.3% respectively, whereas the percentage of participants in the present study (aged 18-61) with eGFR < 60 ml/min/1.73m<sup>2</sup> at baseline and follow-up was 15.2% and 17.4%, respectively, suggesting that CKD prevalence is abnormally high in this predominantly young population. High prevalence of CKD including at advanced stages indicates that the epidemic of CKD is affecting non-agricultural workers in Nicaragua. These results support the hypothesis that occupational heat exposure and socioeconomic conditions are risk factors for decreased kidney function in this region.

### **P03.3970. Cancer Risk in Drivers of Heavy Vehicles: Assessment of Exposure to Petroleum Hydrocarbons, Toxic Effects and Prevention Interventions**

Audil Rashid

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**Abstract:** Cancer development among occupational groups is unnoticed in resource limited settings. Poor drivers of heavy vehicles work for long hours to meet their family needs. As a result of diesel or fuel burning, they are directly exposed to mixture of petroleum hydrocarbons through inhalation, standby activity and skin contact. The purpose of this study is to identify effective methods of exposure prevention to petroleum hydrocarbon carcinogens and associated toxic effects among truck/bus-drivers by completing following specific aims: i) quantify exposure to carcinogens related to work shift; ii) identify urinary and serum biomarkers of carcinogen effect in relation to occupational exposure; and iii) epidemiological analysis of health outcomes to assess the exposure risk to carcinogens. Drivers of heavy vehicles in Rawalpindi were evaluated for exposure to dust, PM10, PM2.5 and polycyclic aromatic hydrocarbons (PAHs). Blood and urine samples were collected for post-shift activities followed by medical surveillance evaluations based on self-reported health outcomes. Initial exposure estimates revealed that with 9 hrs day<sup>-1</sup> or more driving hours have unprecedented exposure to PM10 followed by dust and PAHs. Serum benzo(a)pyrene (BaP), naphthalene and pyrene values (median ranges 9.35, 21.61 and 7.44 µg L<sup>-1</sup> respectively) appeared significantly correlated (coefficient r from 0.43 to 0.58; p<0.001) with exposure. Urinary PAH biomarker 1-hydroxy pyrene > 6.6 µg L<sup>-1</sup> had significantly high prevalence of physical disorders (OR=4.12; 95% CI=1.95-7.58), an indication of carcinogenic effect and indirect exposure to high PAH levels. Among truck drivers, cancer risk evaluation using Incremental Lifetime Cancer Risk Model (ILCR-model 2) suggested 61% had high exposure to petroleum hydrocarbon carcinogens. We conclude that serum pyrene and BaP are important biomarkers for PAH carcinogens.

### **P03.3980. Occupational Physical Activity and Lung Cancer Risk among Participants of the Alberta's Tomorrow Project**

Yun Zhu

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**Abstract:** Purpose Empirical evidence of a possible association between occupational physical activity (PA) and lung cancer risk has been inconclusive. Previous studies have seldom considered occupational exposure to lung carcinogens, which are potentially major confounders that might distort the true effect. This study aimed to investigate the independent association of occupational PA with lung cancer risk, and to determine if this association varies by smoking status. Methods Among participants of the Alberta's Tomorrow Project, we identified 172 incident lung cancer cases and a random sample of 688 non-cases. Data on the longest-held occupation and lifestyle factors were gathered via questionnaires. Using a database generated by our team on the energy expenditures associated with almost 3600 job titles, we assigned metabolic equivalent of tasks to the longest-held job of each participant. Exposure to lung carcinogens in these same jobs was determined using the Canadian Job Exposure Matrix. In preliminary analyses, multivariable logistic regression models have been used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the relation between occupational PA and lung cancer risk. Results Higher occupational PA level was associated with a reduced risk of lung cancer (highest versus the lowest tertile OR=0.50; 95%CI: 0.26-0.95), particularly for non-small cell tumor (OR=0.46; 95%CI: 0.24-0.90). The protective effect of occupational PA was similar among men and women. Additionally, we observed a potential interaction between occupational PA and smoking status, where a decreased risk of lung cancer associated with increasing PA was limited to never smokers (OR=0.27;95%CI: 0.10-0.71; Ptrend=0.008; Pinteraction=0.044). We did not observe evidence for modification of ORs by occupational lung carcinogen exposure. Conclusion Preliminary analysis is suggestive that occupational PA is inversely associated with the risk of lung cancer with a stronger effect in never smokers.

### **P03.3990. Follow-Up Mortality Study of U.S. Railroad Right of Way Workers Having Many Common Health Hazards**

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**Abstract:** Introduction: U.S. Right of Way (MOW) railroad (RR) workers have exposures to diesel and welding fumes, ballast (silica) and asbestos dust, creosote and solvents, and heavy equipment. We hypothesize that these workers have elevated risk for chronic pulmonary and kidney diseases (DIS), neurological ailments, as well as cancers (CA) of the lung, prostate, GI, and lymphatic CAs. Methods: Names of union RR workers were submitted to the U.S. National Death Index for the years 1979 to 2014. When a match was found, these persons were organized into ICD groups. We calculated standardized mortality ratios (SMRs) and 95% confidence intervals (CI) for 11,190 deceased males, aged 18 to 64. Results: Compared to U.S. males, these active-age MOW workers have an all cause SMR of 1.63. Parkinson's and Alzheimer's DIS show elevated SMRs of 3.09 and 7.15; heart DIS has SMR of 2.11; COPD has a SMR of 1.89 (95% CI 1.66, 2.13); kidney DIS has a SMR of 2.50 (95% CI 1.99, 3.01); and transportation accidental deaths have a SMR of 3.27. All CA showed an SMR of 1.79. Stomach, bladder, colo-rectal CAs and leukemia have an approximate risk of 2.0; liver CA has a SMR of 2.36 (95% CI 1.95, 2.78); pancreatic CA produced a SMR of 2.17 (95% CI 1.84, 2.50); lung CA has a SMR of 1.82 (95% CI 1.71, 1.94); prostate CA produced a SMR of 1.93 (95% CI 1.52, 2.34); and bladder CA has a SMR of 1.95 (95% CI 1.35, 2.55). Discussion: With an SMR of 3.27, the risk among RR workers from transport accidents is consistent with hazardous work around heavy rolling equipment. Elevated risks for kidney, heart, neurological DISs, and COPD are consistent with dust or fuel exposures from ballast and other hazards. Our findings suggest that the increased SMR for all neoplasms is likely based on elevated risks for CA of bladder, pancreas, prostate, liver, and lung. Conclusion: Elevated SMRs for many diseases among MOW workers suggests past risks that need to be addressed via additional studies and effective prevention programs.

### **P03.4000. Passive Samplers for the Assessment of Occupational Exposure to Flame Retardants among Canadian E-Waste Dismantlers**

Linh Nguyen

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**Abstract:** The mass of e-waste produced globally is growing dramatically. One hazard, especially for e-waste handlers, are flame retardants (FRs) which are added to electronic and electrical equipment in order to meet flammability standards. FR air concentrations can be measured using active air sampling equipment, but this sampling train can be cumbersome for workers. Passive samplers made from polydimethylsiloxane (PDMS) or silicone rubber, are one option for simplifying the measurement process. Here, we compared PDMS passive air samplers (PDMS-PASs) with active air samplers for the assessment of FR air levels at an e-waste dismantling facility in Ontario, Canada for the purpose of estimating occupational exposure. Sampling was conducted daily over a five days in February 2017. PDMS-PASs were hung at 4 workbenches and a central workplace, and were co-deployed with an active low-volume air sampler which consisted of a GFF followed by a PUF/XAD/PUF sandwich. Each PDMS and low-volume sampler was harvested after 24 hours. Samples were extracted and analysed for 13 FRs, including novel brominated flame retardants (NFRs), polybrominated diphenyl ethers (PBDEs) and organophosphate esters (OPEs), using gas chromatography mass spectrometry (GC-MS). The most abundant FRs were the now-banned PBDEs (BDE-209 accounted for ~70-98 % of FRs collected by PDMS-PASs). Total median concentrations of PBDEs in PDMS-PASs at the central workplace and workbenches were 1930 and 2900 ng/m<sup>3</sup>, respectively. PDMS-PASs provided comparable estimates of air concentrations to active samplers. The chemical profiles from the PDMS matched those from active sampling, indicating that differences in compound gas-particle partitioning did not affect the sampling efficiency of PDMS. Levels of FRs in air collected from this Canadian e-waste recycling facility suggest PDMS-PASs can be used to estimate occupational exposure to FRs, even for short deployment times at workplaces with elevated levels of these chemicals.

### **P03.4010. Occupational Exposures and Thyroid Disease Risk in Young Adults: Results from Project ELEFANT**

Hyang-Min Byun

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**Abstract:** Background: Thyroid disease is one of the leading endocrine disorders, with disruption of thyroid stimulating hormone (TSH) levels commonly implicated in disease aetiology. Aims: We sought to examine associations between occupational exposure to radiation, organic solvents and vibration in relation to TSH levels and risk of thyroid diseases. Methods: We utilized data from 124,286 participants within Project Environmental and Life Style Factors in Metabolic Health Through Life-course Trajectories (ELEFANT). Participants were aged between 18 and 40 and reside in Tianjin, China. Questionnaire data on lifestyle and occupational exposures was collected, and medical records reviewed to collect data on history of thyroid disease. TSH levels were measured by automated immunometric assay. Results: The participants were predominantly from the Han ethnic group (97.9%), lived in rural areas (63.7%), and worked as farmers (52.6%). The prevalence of thyroid disease was 0.4% (n=528). In logistic models adjusted for confounders (age, BMI, education, residence, occupation, smoking and co-exposures), exposure to radiation [odds ratio (OR): 1.73; 95% CI: 1.1-2.7], organic solvents [OR: 2.0; 95% CI: 1.3-2.9] and vibration [OR: 4.4; 95% CI: 2.0-8.75] were significantly associated with higher risk of thyroid disease. TSH levels, measured only in women (median: 1.95 mIU/L; 95% CI: 2.45-2.77 mIU/L), were observed to be associated only with vibration exposure ( $\beta$  (95% CI): 2.80 (1.07-4.54) mIU/L;  $p=0.0016$ ). Conclusions: Our data demonstrate for the first time that vibration exposure is associated with significantly increased TSH levels and increased risk of thyroid disease. Further work is required to establish the mechanisms underlying this association.

### **P03.4030. Exposure to Metal Fume Particulate Matter and Advance Glycation End Products in Welding Workers: A Longitudinal Study**

Ching-Huang Lai

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**Abstract:** Previous studies have demonstrated the association of exposure to air pollution and the diabetes mellitus (DM). Insulin resistance has been regarded as an underlying mechanism of type 2 DM. Studies have shown transition metal ions play important roles in the Maillard reaction. The objective of this study was to assess the effects of metal fume particulate matter and nickel (Ni) on insulin resistance among the welders and to understand its association with advanced glycation end products (AGEs) formation. This study was in a longitudinal design. Study subjects consisted of 74 welders and 28 office workers from a shipyard of northern Taiwan at baseline Oct, 2014 and followed up annually on Oct to Nov, 2015 and 2016. Participants were asked to wear a PM2.5 sampler during their working hours on the first weekday (Monday) and collected urine and fasting blood samples on the next day (Tuesday) morning. A total of 233 measurements were collected and included in the subsequent statistical analyses. Urinary Ni was assayed as biomarkers of internal dose of nickel exposure. Plasma adiponectin and AGEs were measured as biomarkers of cardiovascular effects. Urinary 1-hydroxypyrene (1-OHP) was used as a biomarker of exposure to polycyclic aromatic hydrocarbons (PAHs). Personal PM2.5 exposure levels were significantly associated with urinary 1-OHP concentrations according to the generalized estimating equation (GEE) analysis after adjusting for confounds. Log(Ni) was negatively associated with log(Insulin)( $\beta = -0.056$ , 95% CI -0.110 to -0.001,  $p < 0.05$ ). Log(Ni) was positively associated with log(adiponectin)( $\beta = 0.160$ , 95% CI 0.080 to 0.238,  $p < 0.001$ ). Log(Ni) was positively associated with log(AGEs)( $\beta = 0.119$ , 95% CI 0.041 to 0.197,  $p < 0.01$ ). Urinary Ni levels are associated decreasing insulin levels. Urinary Ni levels are positively associated with formation of AGE. Exposure to metal fume particulate matter may increase advance glycation end products in welding workers.

### **P03.4040. Exposure Neuroepidemiology Study among Occupational Groups with High Exposure to Aviation Emissions**

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**Abstract:** Aviation industry personnel working at the airports in Pakistan are confronted with neurasthenic and physical problems mainly because of unprecedented exposure to jet fuels and also there is no proper health monitoring services are extended to them. We aimed to assess dermal exposure of workforce at airports to jet propellant (JP) fuel (e.g. JP4, JP5, and JP8) which contains a complex of mixture of Polycyclic Aromatic Hydrocarbons (PAHs). To document the extent of acute toxic exposure levels, protective strategies, working hours and job nature were used as predictors. Among aviation workforce members, who work for more than six hours per day, we took both skin pad and urine samples to measure dermal exposure by PAH and subsequent secretion through body. To detect biological marker for dermal exposure urinary pyrene metabolite was quantified. The results show that workers at the airport have high jet fuel dermal exposure. However, the mean pyrene exposure levels were reduced to 33% when they use masks during work. Urinary 1-hydroxypyrene was detected as the biological measure to quantify the internal exposure to PAHs present in JP fuels whose concentration was relatively low (range 35 and 174 nmol) when compared to dermal exposure levels. Workers exposed to 6 hour per day or more had significantly high prevalence of physical disorders (OR=3.17, 95% CI=1.33-7.12). Neurasthenic symptoms (e.g. energy loss, fatigue, fainting, twitching, sleeplessness, irritability, body aches) were found in 58% of the subjects and were associated with years of involvement in job. In aviation industry, working at the airport for ten years or more attributed substantial development of neurasthenic effects (OR=3.85, 95% CI=1.71-8.84). Results of multiple regression analysis revealed mass balance between dermal pyrene dose and 1-hydroxypyrene excretion that confirmed the relevance of the dermal exposure route.

### **P03.4050. Pulmonary Dysfunction in Indium Tin Oxide Exposed Workers**

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**Abstract:** Aim: To investigate the relationship between indium exposure and lung effects markers among indium tin oxide (ITO) manufacturing workers without job change. Methods: We enrolled 179 male workers from ITO target manufacturing and recycling factories in Taiwan. All workers were categorized into three groups---high exposure, low exposure, and reference group. Plasma indium (P-In), urine indium (U-In) and creatinine adjusted U-In (U-In/Creat.) were used as internal dose of indium exposure. Plasma Krebs von den Lungen-6 (KL-6) and surfactant protein D (SP-D) were used as markers of interstitial pneumonitis. Forced vital capacity (FVC), forced expiratory volume at 1st second (FEV1), and FEV1/FVC ratio were also evaluated by spirometry. Demographics and potential confounders were collected by a self-administered questionnaire. Results: Compared to reference group, significantly increased levels of P-In, U-In, and U-In/Cre were observed in high exposure group and low exposure group. After adjusted for covariates by linear regression, plasma, urinary and creatinine adjusted indium were increased in high exposure group and low exposure group with comparison to reference group. Plasma KL-6 was higher in high exposure group ( $\beta=0.24$ ,  $p<0.05$ ) compared to reference group, but not for surfactant protein D (SP-D). Furthermore, FVC and FEV1 were reduced in both high exposure group (FVC:  $\beta=-0.08$ ,  $p<0.01$ ; FEV1:  $\beta=-0.05$ ,  $p<0.05$ ) and low exposure group (FVC:  $\beta=-0.06$ ,  $p<0.05$ ) compared to reference group. Conclusion: Our findings indicate indium exposure was related to restrictive lung dysfunction, decreased lung function for both FEV1 and FVC test but not for FEV1/FVC ratio. Meanwhile, increased plasma KL-6 in high exposure group also supports that indium exposure results in increased risk of interstitial pneumonitis among direct indium exposure workers. Our study provided an explanation to the consequence of indium exposure- interstitial pneumonitis-restrictive lung dysfunction.

### **P03.4060. The Effect on Workers of Indoor Air Quality in Underground Commercial Spaces**

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**Abstract:** Background/Aim Indoor air quality in underground commercial spaces can affect the health of workers and trigger illnesses such as sick building syndrome (SBS), which causes symptoms such as headaches and coughing. This study conducts a survey of the current indoor air quality in underground commercial spaces in the Seoul metropolitan area and determines the associated health effects on workers in underground commercial spaces using a self-reporting questionnaire. Methods Indoor air quality concentrations (temperature, humidity, CO, CO<sub>2</sub>, total culturable bacteria and fungi, total volatile organic compounds and formaldehyde) were obtained in underground commercial spaces. The health effects on 314 workers in commercial spaces were determined by analyzing the results of self-reporting questionnaires relating to subjective symptoms. Results In the environmental assessment questionnaire, 34.4% of the respondents reported having smelt musty odors, and 28.0% had smelt unpleasant odors in the work space for the past month. Health effects relating to SBS were the highest. Skin and mucous membrane, mental, respiratory, and systemic symptoms were reported to have been experienced by 71.0%, 64.3%, 56.1%, and 50.0% of respondents during the past month. SBS symptoms of workers were positively correlated with indoor air quality parameters. Odor, humidity, and cognitive indexes were related more to skin mucosal symptoms than to other symptoms. Furthermore, these symptoms were related to business types and were especially common in workers within the fashion goods industry. Conclusions Results indicate that people who work within the fashion goods industry are more likely to be exposed to a greater amount of indoor air pollutants than those working in other industries. In future studies, it is necessary to evaluate the relationships between indoor air quality in the workplaces and business types.

### **P03.4070. The Impact of an Occupational Injury on Developing Psychiatric Disorders in Taiwan**

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**Abstract:** Background: Injuries are known to be a relevant risk factor for psychiatric disorders. Psychiatric disorders were found increased after occupational injury, and such increase was observed up to six years after injury. However, comparison with uninjured workers was not done. Objective: To assess the impact of occupational injury compared with non-occupational injury and no injury on developing psychiatric disorders in Taiwan working population. Method: We used Taiwan's National Health Insurance Research Database (NHIRD) to investigate the incidence of suicidal attempt, traumatic stress related disorders, depressive disorders, anxiety, and substance and alcohol abuse and dependence in one million Taiwan people. Patients aged between 20 and 50 in 2000, were employed, did not have any injury before 2000, and did not suffer psychiatric disorders before 2000 and injury event were included. All participants were classified into three groups such as suffering an occupational injury, non-occupational injury, and no injury. Individuals in each group were matched by age, sex, insured salary while injury or diagnosed happened, and calendar year of injury happened. Data were analyzed by survival analysis and adjusted for age, sex, insured salary before injury. Results: A total of 12,528 patients was included into final analysis. Compared with uninjured workers, occupational injury was associated with a higher risk of suicidal attempt (Hazard Ratio, HR=21.47, 95% CI=2.89-159.31), traumatic stress related disorders(HR=1.60, 95% CI=1.07-2.39), depressive disorders (HR=1.91, 95% CI=1.50-2.43), anxiety disorders (HR=1.46, 95% CI=1.26-1.68 ), and substance and alcohol abuse and dependence(HR=2.67, 95% CI=1.71-4.19). Furthermore, we found that works with non-occupational injury had similar increased risk of developing psychiatric disorders. Conclusion: In this fourteen years follow-up study, we found that injury increased risks of developing suicide attempt and psychiatric disorders.

### **P03.4080. Epidemiological Profile of Poisoning in Workplace Compulsory Notifications in the Brazilian Notifiable Diseases Information System from Municipalities of São Paulo State**

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**Abstract:** The Brazilian Notifiable Diseases Information System (SINAN) introduced, in the middle of 2007, forms for reporting injuries and diseases related to work by every health care unit in the country. Therefore, this study aimed to describe the epidemiological profile of the poisoning in workplace notifications for three São Paulo State municipalities from 2008 to 2014. This was a descriptive time-series study. Data were collected from the SINAN for the municipalities of Araraquara, Piracicaba and Campinas from 2008 to 2014. Data were processed and evaluated using STATA software. The variables analysed were: sex, age, occupation, toxic agent, health unit attendance, route of exposure, and exposure circumstance. Trend in the number of notifications was assessed by a Prains-Winsten regression model. A total of 367 occupational poisoning events (75.2% among men, 24.8% among women) were notified in the study period, including 7 cases involving underage workers. The age mean was 35 years (SD=12). Most of the notifications were attended in primary health care (82.4%), and 29.3% among petrochemical operators. The most common groups of toxic agents were industrial chemical products (64.6%) followed by pesticides (16.9%). Regular use of the toxic agent was the main poisoning circumstance (71.1%). Accidental events came as the second more usual circumstance of intoxication (18.8%). Regarding the exposure route, the respiratory was the mean route (80.4%), followed by dermal contact (11.7%). The study revealed a decrease of 12 notifications number per year in the study period. As far as it is known, this was the first study that described the profile of poisoning in workplace for these municipalities with SINAN data. The number of notifications was low suggesting important underreporting, considering the profile of the municipalities, and the contingent of workers at risk. Moreover, the decrease in notifications over the years indicates a worsening of this injurie surveillance.

**P03.4110. Profiling Noise Induced Hearing Loss among Selected Auto-Rickshaw Drivers in Chennai City, India: A Pilot Study**

Krishnendu Mukhopadhyay

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**Abstract:** Background: The main reasons of city noise pollution in India are vehicle density and traffic congestion. Frequent travelling in auto-rickshaws in most of Indian urban areas may lead to noise-induced hearing loss (NIHL) where drivers are primary victims followed by its daily passengers and outside commuters. This study was conducted to evaluate the prevalence of NIHL among auto rickshaw drivers in three selected routes in Chennai city, India. Methods: Thirty drivers with age-range between 26 and 58 years and a minimum of five years driving experience were included in this study. As per questionnaire records, they had no history of hearing disabilities at the beginning of this profession. Noise Dosimeter was used to assess personal noise and pure-tone audiometric testing was conducted to quantify hearing loss for all participants. In an average, they were found to have on driving mode for about 4 hours and would wait in auto-rickshaw stands for another 4 hours during 8 hours personal monitoring. Consequently, a few stand areas were monitored using Sound Level Meter (SLM) to assess background noise. Measurements were taken thrice within three consecutive months starting from January 2016. Relevant questionnaires and participants' informed consents were also taken into account for ethical approval from the institute. Results: Average 8 hours personal exposures and area noise levels were recorded as 92.02 and 79.30 dBA, respectively; higher than prescribed permissible limits. Among all participants, 23 (76.7%) were found to have noise induced hearing loss as diagnosed by Air and Bone Conduction tests. Conclusion: Studies on noise exposure assessment among auto-rickshaw drivers are still inadequate in India. Despite a few limitations of recruiting auto-drivers in larger scale, the findings of this study would encourage to conduct more organized epidemiological studies on hearing loss even for long-distance professional drivers.

### **P03.4120. Can Time-Lapse Photography Improve Task-Specific Risk Characterization in Informal Labor Sectors?**

Zoey Laskaris

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**Abstract:** Aim: To generate time-activity patterns (TAPs) using time-lapse photography and describe differences in particulate matter (2.5 and 10 $\mu$ m) concentrations ( $\mu$ g/m<sup>3</sup>) across job tasks among informal electronic-waste (e-waste) recovery workers in Accra, Ghana. Background: Many of the highest occupational exposures occur in informal occupational sectors among unprotected workers around the globe. Characteristics of informal sectors present challenges in capturing these exposures and linking them to work tasks; informal work settings often lack defined physical and organizational structure and a consistent work-flow. A common method used in occupational settings to identify job tasks associated with health and safety hazards are time-activity diaries (TAD). These diaries may be limited in their ability to capture the high variability in tasks and short-term peak exposures characteristic of informal sectors. Moreover, they can be cumbersome for the participants and with low validity. An improved method may be the use of time-lapse photography to render individual TAPs with high resolution without relying on worker self-report. Method: The participants are enrolled in a prospective occupational cohort study, GeoHealth-II based in Accra, Ghana. 100 informal e-waste worker participants wore air sampling backpacks during a work shift. Backpacks are equipped with a front-mounted GoPro camera, and real-time and gravimetric (filter-based) particulate matter sampling devices (sizes 2.5 and 10 $\mu$ m). Additionally, participants filled out a standard TAD with a 30-minute resolution. We developed a data collection tool to log all activities and relevant photo details identified in the photos and interviewed workers to validate our task assignments. Results: This poster will describe our method of generating TAPs and our results based on its application. Results include tasks performed on an e-waste site (type and duration) and their corresponding PM (2.5 and 10 $\mu$ m) concentrations ( $\mu$ g/m<sup>3</sup>).

### **P03.4130. Relationship between Blood Lead Levels and Dietary Essential Mineral Intake in Electronic Waste Workers and a Control, in Ghana**

Sylvia Takyi

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**Abstract:** Background: Several toxic metals are known to interact with, and affect absorption of micro nutrients in the gastro-intestinal tract. Although studies have reported high levels of lead (Pb) in electronic waste (e-waste) workers, the possible interaction and impact on availability of essential minerals in the body have not been extensively studied. Objectives: The aim of this study was to investigate the relation between blood lead levels (BLL) and dietary essential mineral (Ca, Fe, Mg, Zn, Cu) intakes of e-waste workers and a control group. Methods: This prospective cohort study, which is part of the ongoing West Africa GEOHealth II project, compared 100 e-waste workers at Agbogbloshie (exposed) to 50 controls (unexposed). 10 ml of whole blood was collected and analyzed for Pb using the Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Essential mineral intakes were assessed using a 2 day 24 hour recall and analyzed by the Esha F-Pro nutrition software. Statistical analysis was done using SPSS (Version 22). BLL and essential minerals were reported using means, standard deviations (SD) and ranges. Results: Overall, mean (SD) BLL was higher ( $9.24 \pm 6.37 \mu\text{g/dL}$ ) in e-waste workers, range (2.42-41.60  $\mu\text{g/dL}$ ) than the control group ( $4.10 \pm 1.92 \mu\text{g/dL}$ ), range (1.51-14.04  $\mu\text{g/dL}$ ). BLL levels were mostly above 10  $\mu\text{g/dL}$  at e-waste site (28%), compared to control site (2%). Mean intakes of Ca, Zn, Cu and Mg in the diet were low in both groups, but Fe was adequate. A simple linear regression model showed a positive relationship between BLL and Ca intake ( $r = 0.39$ ,  $p < 0.001$ ). Conclusions: Diet taken lacked adequate levels of Zn, Cu and Mg among all study participants. There was a positive relationship between Ca levels and BLL. This preliminary data suggests the need to supplement existing dietary intake with certain micronutrients. Key Words: Essential minerals, Lead, Whole Blood, E-waste, Ghana

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