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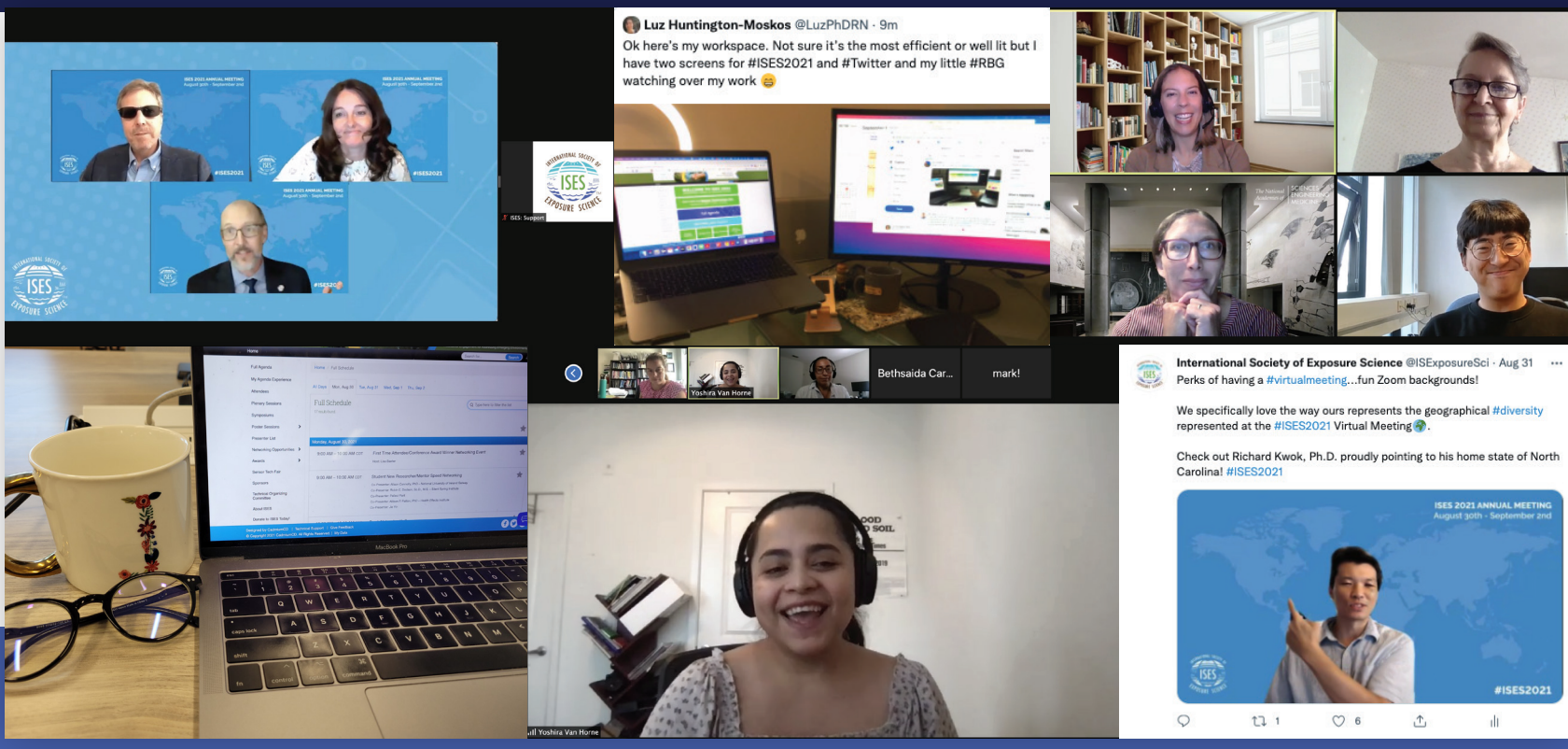

ISES 2021

ANNUAL MEETING • VIRTUAL EXPERIENCE

August 30th - September 2nd, 2021

Theme: Multisector Engagement for Addressing Emerging Environmental Exposures

PROGRAM

APPLICATION OF SENSORS IN EXPOSURE SCIENCE

1039924

Characterizing the external exposome using passive air samplers – comparison of chemical exposures using different wearable form factors

E. Lin, E. Lin, A. Nichols, Y. Zhou, J. Koelmel, K. Godri Pollitt; Yale University

Abstract: Organic contaminants are released into the air indoors from various building materials and personal care and household products. Low-cost and wearable passive sampler have emerged as an approach to facilitate characterization of personal chemical exposures for epidemiological and exposure science studies. Placement of these samplers on an individual to best capture their exposures to environmental contaminants has not been evaluated. In this study, we performed a comparative assessment of exposures airborne contaminants detected using wearable passive air samplers placed at different positions on the body. Participants (n=32) wore four passive samplers on the head, chest, wrist, and foot for 24 hours during summer 2019 and winter 2020. Exposure to 56 airborne organic contaminants was evaluated using thermal desorption gas chromatography high resolution mass spectrometry. Exposure levels detected by the four samplers were all dominated by five phthalates with the highest concentrations were found for samplers positioned on the head. Exposure to 17 compounds, including nicotine and delta-9-tetrahydrocannabinol, were found to significantly vary across season for samplers worn on the foot and chest. While distinct exposure profiles were detected by samplers placed at each location, no statistical differences were found between concentrations measured by chest and wrist samplers with compound-compound correlations for all chemicals. In contrast, head and foot samplers had the weakest compound-compound correlations across compounds evaluated, showing that these placements were least similar in exposure profiles. In conclusion, our results suggest wearable samplers worn at different locations of the body can be used to detected similar exposure sources given the strong positive correlations between sampling positions. In future exposure and epidemiological studies, wearable passive sampler placement influences measured exposure levels and should be considered.

Keyword:air sensor, environmental health, other (specify below), air toxics, SVOCs, Personal Exposure Assessment

1042583

Comparison between area and personal real-time monitor measurements from indoor settings in Northern Arizona.

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Abstract: The development of affordable and portable air monitors provides the ability to measure personal exposures in real-time. Most people spend 90% of their time indoors, yet most epidemiological studies focus on outdoor air pollutants exposure. This study compares area and personal concentrations of particulate matter 2.5µm in size (PM2.5) collected inside homes in Northern Arizona during heating and non-heating season between 2017 and 2020. Indoor air samples were continuously measured for 24 hours; a personal data logger ram (pDR-1500) active particulate monitor with a PM2.5 cutoff was placed in the living room as

an area sampler for each household. Participants wore the MicroPEM (personal aerosol exposure monitor) for approximately 24 hours during the sampling period. Log-transformed measurements from both devices were analyzed using a descriptive and inferential approach to identify correlations and lags among measurements. The mean Micropem PM2.5 concentrations during the non-heating season were 7.82 μg/m3 and 12.31 μg/m3 for the pDR. Mean concentrations for the heating season were higher for both devices MicroPEM was 28.94 μg/m3 and 57.91 μg/m3 for the pDR. Cross-correlation analysis results for the non-heating season showed 10 out of 34 houses have significant lags, and 24 out of 50 during the heating season. The critical difference between devices is 3.26 standard deviations for the heating season and 2.36 for the non-heating season. Our findings in this study suggest that personal exposures are not always correlated with area samplers indoors

Keyword:air quality sensor, particulate matter (PM), built/indoor environment

1042693

Socioeconomic disparities in ambient PM2.5 concentrations and a low-cost air quality sensor network in California

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Abstract: Background: Understanding the relationship between socioeconomic status (SES) and race/ethnicity with environmental hazards, such as air pollution, is crucial for improving environmental justice as well as advancing epidemiological research. Uneven and sparse distribution of government-operated air monitoring stations results in a limited ability to measure particulate matter (PM) at a high spatial resolution. The rapid development of low-cost air quality sensors in recent years allows for more widespread monitoring at a higher spatiotemporal resolution and therefore an opportunity to improve spatiotemporal characterization of air pollution exposure. Objectives: To examine the disparity of PM2.5 exposure and monitoring in California based on neighborhood socioeconomic factors. Methods: Real-time PM2.5 measurements (2017-2020) were obtained from the low-cost PurpleAir sensors in California. SES variables were obtained from the CalEnviroScreen3.0 dataset. Spatial-temporal analyses were conducted at Census tract-level to investigate SES in relation to the distribution of sensor deployment, operational status, and PM2.5 concentrations. Results: Both the spatial coverage and the number of PurpleAir sensors increased significantly in California from 2017 to 2020. Sensor-based PM2.5 concentrations were higher among Census tracts with low SES, high asthma rates, heavy overall pollution burden, and high racial/ethnic minority population groups. However, more PurpleAir sensors were deployed in more affluent communities with lower disease and pollution burdens. Our results suggest a large proportion of deployed sensors were not in operation at a given time. The operational condition of the sensors was likely affected by unusual or extreme events, such as the COVID-19 pandemic and major wildfires, especially in disadvantaged communities. Conclusion: This study found that SES and race/ethnicity were related to the availability of measurements and exposure levels of PM2.5 among Census tracts in California. Deprived communities with high concentrations of estimated PM2.5 should be given priority for future sensor deployment. Further, sensor deployment must be paired with regular maintenance and quality check to ensure the reliable performance of the sensors, which is essential to inform health and environmental justice-related interventions and

therefore optimize the benefits of the low-cost air quality sensor network.

Keyword:air pollution, air quality sensor, environmental justice

1042786

Beyond exposure data in air-quality sensor campaigns

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Abstract: Low-cost stationary and wearable air-quality sensor devices have lately gained a foothold in personal exposure monitoring. Individuals are equipped with sensor devices in Citizen Science (CS) type of research settings. However, currently little is known about the participants' experiences in these studies. This work enlightens participants' experience, motivations, risk perceptions and underlying predictive factors into behavioural changes in air quality exposure campaign held in Ljubljana, Slovenia as part of the EU H2020 ICARUS project multi-sensor personal exposure study. 82 individuals took part in winter- and summer campaigns hosting stationary indoor Air Quality Sensor device (IAQ), a Smart Activity Tracker (SAT), a Portable Particulate Matter (PPM) sensing device an a silicon wristband for passive sampling of organic chemicals. The participants answered pre-and post-surveys about their participation experience. Open ended answers were analysed thematically while re-occurring questions were analysed statistically. Additional information about participation and their comprehension of the data that was collected was gained through a focus group of five participants which was organized after the campaigns. This information was used to prepare individual results reports based on the participants feedback. Specific results of the above mentioned surveys and focus groups will be presented. Participants in exposure studies represent additional source of information and are important part of the research. Cross-disciplinary approaches are needed in order to understand the participants' views and carry out research to shed light beyond exposure data. This approach creates win-win situations and can improve the participants experience, identify design faults and improve the overall study design in future studies involving CS.

Keyword:air quality, air quality sensor, other (specify below), participation experience

1042963

Personal Air Pollutant Exposure Monitoring in South African Children Participating in the VHEMBE Study

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Abstract: Children from rural areas in the developing world can be exposed to harmful environmental contaminants on a daily basis. The burden of disease caused by toxic

exposures disproportionately effects low and middle income countries, where children in the developmental stage are particularly vulnerable to the adverse health effects. Quantifying exposure levels and identifying characteristics that are associated with exposure has been challenging due to limitations in monitoring techniques. Within the last decade, passive sampler wristbands have shown to be a convenient and reliable tool for analyzing personal exposures. They are especially practical for vulnerable populations, yet few studies have been conducted on children outside of the United States. In this study, passive sampler wristbands, known as FreshAir wristbands, were worn by 49 children aged 5-years from various villages in Limpopo, South Africa. The study leveraged ongoing research within the Venda Health Examination of Mothers, Babies, and their Environment (VHEMBE). The wristbands contained polydimethylsiloxane (PDMS) sorbent bars, which were analyzed after sampling using thermal desorption gas chromatography high resolution mass spectrometry. A total of 32 analytes belonging to 10 different chemical families were detected in greater than 50% of the wristbands worn by the children. Exposure to pollutants including organochlorine pesticides, phthalates, and organophosphate ester (OPE) flame retardants were identified in the wristbands. Higher concentrations of PAHs were observed among children from households that fell below the food poverty threshold, did not have access to electric stoves and burners for indoor cooking, and reported longer durations of cooking or burning materials during the sampling period. Concentrations of p,p'-DDD and p,p'-DDT were also found to be higher for children from households falling below the food poverty threshold and significantly higher for children whose households were sprayed for malaria control within the previous 1.5 years. This study demonstrates the reliability of using passive sampler wristbands as a non-invasive method for monitoring exposures, and identifies airborne environmental contaminants as well as observed trends in concentration levels for children in South Africa. Future studies are needed to further identify and understand the effects of airborne environmental contaminants on childhood development and strategies to mitigate exposures.

Keyword:children, pesticides, exposure factors

1043053

Characterizing Satellite-Derived Air Quality Measurements for Health Applications

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Abstract: Cardiovascular morbidity incidence, stimulated by adverse air quality (AQ), demonstrates the urgency of widespread and accurate pollutant measurements. Air quality data is obtained primarily from ground-based air quality monitors which are most accurate when patients live within 25 miles, and due to geographical and financial limitations, monitors are generally located in population-dense areas. Contrarily, satellite data from the National Aeronautics and Space Administration (NASA) gives access to widespread spatiotemporal air pollution data through daily global exposure coverage of NO2 and PM2.5

concentrations through geographic coordinate-specific values. The primary objective of this project is to validate the use of satellite air quality monitors for PM2.5, and NO2, with the hope of utilizing the data to better understand the health impacts of exposure to currently under monitored populations. Through NASA's MERRA-2 PM2.5, NASA's Ozone Monitoring Instrument NO2, and the Environmental Protection Agency's NO2 and PM2.5 concentration measurements, 15 years of chemical pollution datasets specific to each United States county were compiled. A descriptive statistical analysis was done for overlapping monitor and satellite locations and dates. To further test the validity of the satellite-obtained measurements, satellite data from mountainous, desert, wetland, and coastal terrains were compared to EPA measurements from the same locations with a T-test, Z-test, bland-altman test, and regression analysis. Results indicated similar trends between the EPA on-ground monitor data and the MERRA-2 satellite data, with discrepancies during the winter months. Furthermore, there is a proportional relationship between the difference between daily dataset values and a unit increase in the mean chemical pollution value. Through further analysis of our results, the disadvantage of satellite data providing less reliable data in desert areas, and areas with snow and cloud coverage, will be quantified to validate the use of satellite data in health applications. This will be the first step to attain a more thorough representation of air pollution exposure to a wider swath of the US population, and the subsequent evaluation of the impacts atmospheric pollution has on various diseases such as COVID-19 and Type 2 Diabetes Mellitus.

Keyword:air pollution, air quality sensor, COVID

1043300

Using Proton Transfer Reaction Time-of-Flight Mass Spectrometry for Real-Time Characterization of Volatile Organic Compounds in Indoor Air at a U.S. EPA Superfund Site

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Abstract: Background. Tetrachloroethylene (PCE) has been found at many hazardous waste sites due to its widespread use in dry cleaning and metal degreasing operations. PCE exposure is a major health risk for nearby communities. The Pike and Mulberry Streets PCE Plume, located in Martinsville, Indiana, is a U.S. EPA Superfund Site. Authorities have been working on remediation of the chemical contamination over the past 19 years. The Indiana Department of Environmental Management conducted a removal program from 2004-2008. The U.S. EPA collected samples of soil and indoor air from 2016-2017. These efforts have been primarily focused on measuring PCE in the environment, leaving the complex nature of human exposure to PCE unaddressed. PCE often co-occurs with its degradation products and other volatile organic compounds (VOCs). Our aim for this pilot project is to test the feasibility of using a state-of-the-art mobile lab equipped with a proton transfer reaction time-of-flight mass spectrometer (PTR-TOF-MS) for real-time (1 Hz) characterization of PCE and chlorinated VOCs in indoor air potentially due to vapor intrusion from contaminated groundwater. If proven to be feasible, PRT-MS can be used in field studies to better characterize human exposure to VOC contaminations. Methods. We collected 48-hour continuous real-time air monitoring data from four (n=4) properties that were located inside (2), at the edge (1), and outside the Superfund Site (1). Measurements were carried out

continuously to characterize spatiotemporal variations inside each property. Results and Conclusion. The average PCE concentration in Property#1 was 50.1 µg/m3, with a maximum of 126.4 µg/m3, exceeding the U.S. EPA's action level of 42 µg/m3 in residential indoor air for chronic health effects. We also detected PCE degradation products, such as trichloroethylene (TCE), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE), and vinyl chloride at this property. PCE and other VOCs were detected at very low concentrations in other properties, with a maximum PCE concentration of 4.97, 1.71, and 2.95 µg/m3 at Property #2, #3, and #4, respectively. This indicates that: 1) the vapor intrusion mitigation system installed in Property #2 effectively reduced VOC levels in the indoor environment, and 2) the current boundary of the Superfund Site was appropriate near Property#3. Our data demonstrate that PTR-MS can be used to characterize community exposure to VOC contamination.

Keyword:environmental health, VOCs, public health

1044222
Development a powerful Exposometer for precision environmental health
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Abstract: Human health is regulated by complex interactions between the genome and environment. While extensive research has been conducted on the genome, little was known on the human exposome, especially at the individual level. The exposome refers to the totality of chemical, biological, and physical exposures that individuals encounter over their lifetime. Components of the exposome, both individually and collectively, contribute to human health and disease etiology. Similar to precision health, precision environmental health (PEH) takes into account individual variabilities in response to environmental exposures and intervention. PEH calls for devices that allow monitoring of environmental exposures at the individual level with high spatial temporal resolution. Traditional environmental monitoring methods only target specific substances, whereas exposomics approaches identify and quantify thousands of substances simultaneously using non-targeted high-throughput and high-resolution analyses. Current methods of monitoring, relying on total concentrations of particulate matter (PM) and a handful of substances, cannot reflect the complex nature of human exposome, let alone providing evidence for precision health. Here, we propose a wearable device that captures the diversity of airborne exposome and allows the users to get a comprehensive view of their exposures. The device, termed exposometer, collects all traditional environmental parameters measured by fixed weather stations at the individual level. Moreover, paired with next generation sequencing (NGS) and high-resolution mass spectrometry (MS), the device provides the most detailed view of the human airborne exposome.

Keyword:air sensor, environmental health, exposure models, exposome

1043092
Openly accessible low-cost measurements in PM2.5 exposure modeling: guidance for monitor deployment

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Abstract: High-resolution, high-quality exposure modeling is critical for assessing the health effects of PM2.5 in epidemiological cohorts. Sparse ground-level PM2.5 measurements, as key model input, may result in two critical issues in high-resolution exposure prediction: (1) they may affect the models' accuracy in predicting the spatial distribution of PM2.5; (2) internal evaluation based on these measurements may not reliably reflect the model performance at the locations of interest (e.g., cohort residence locations). This study aimed to take advantage of PM2.5 measurements from an openly accessible low-cost PM2.5 network, PurpleAir, with an external validation dataset at residence locations of an epidemiological cohort to improve the accuracy of exposure prediction at the cohort locations, and propose metrics assessing the similarity between the monitor and cohort locations to guide future monitor deployment. We utilized a spatiotemporal modeling framework to incorporate PM2.5 measurements from 51 agency/non-agency stations and 58 PurpleAir monitors in the Puget Sound region of Washington into high-resolution exposure assessment. A similarity metric based on principal component analysis (PCA) was developed to assess the PurpleAir monitors' representativeness of the cohort locations. After including calibrated PurpleAir measurements as part of the dependent variable, the spatiotemporal validation (at the two-week level) R2 (root-mean-square error, RMSE) improved from 0.84 (2.22 μg/m3) to 0.92 (1.63 μg/m3). The spatial validation (in the longer term) R2 (RMSE) improved from 0.72 (1.01 μg/m3) to 0.79 (0.88 μg/m3). The exposure predictions showed a more realistic spatial pattern as well. We found that the PurpleAir monitors with shorter PCA distances could improve the model's prediction accuracy more substantially than monitors with longer PCA distances. To our knowledge, this was the first attempt to evaluate the benefits of low-cost PM2.5 measurements for long- and short-term exposure prediction at cohort residence locations and to provide practical guidance for future monitor deployment with similarity metrics.

Keyword:fine particlate matter, exposure models, sensor technology

1046718

Impact of 4th of July fireworks on spatiotemporal PM2.5 concentrations in California based on the PurpleAir sensor network: Implications for Policy and Environmental Justice

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Abstract: Fireworks are often used in celebration, causing short term, extremely high particulate matter air pollution. In recent years, the rapid development and expansion of low-cost air quality sensors by companies such as PurpleAir has enabled an understanding of air pollution at a much higher spatiotemporal resolution compared to traditional monitoring networks. In this study, real-time PM2.5 measurements from 751 PurpleAir sensors operating from June to July in 2019 and 2020 were used to examine the impact of 4th of July fireworks on hourly and daily PM2.5 concentrations at the Census tract and county levels in California. American Community Survey (ACS) and CalEnviroScreen3.0 data were used to identify correlations between PM2.5 and socioeconomic status (SES). A two-step method was

implemented to assure the quality of raw PM2.5 sensor data and sensor calibration against co-located reference instruments. Results showed that over 67% and 81% of counties experienced immediate impacts related to fireworks in 2019 and 2020, respectively. Relative to 2019, peak PM2.5 concentrations on July 4th and 5th of 2020 were over 50% higher in California, on average, likely due to the COVID-19-related increase in the use of household-level fireworks. This increase was most pronounced in southern counties, which tended to have less strict firework-related regulations and greater use of illegal fireworks. Los Angeles County experienced the highest July 4th daily PM2.5 levels both in 2019 (29.9 µg.m-3) and 2020 (42.6 µg.m-3). Spatial hot spot analyses generally showed these southern counties (e.g. Los Angeles County) as regional air pollution hotspots, whereas the opposite pattern was seen in the north (e.g. San Francisco). Results also showed over two-times higher PM2.5 peaks among communities with lower SES, higher minority group populations, and higher asthma rates. Our findings highlight the important role that policy and enforcement can play in reducing firework-related air pollution and protecting public health, as exemplified by southern California where the policy was more relax and air pollution was higher (especially in 2020 when the 4th of July coincided with the COVID-19-lockdown period), and in disadvantaged communities where disparities were greatest.

Keyword:particulate matter (PM), air quality sensor, environmental justice, Firework

1048307

Features and Practicability of the Next-Generation Monitors and Sensors for Exposure Assessment to Airborne Pollutants: A Systematic Review

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Abstract: In the last years, the issue of exposure assessment to airborne pollutants is on the rise both in environmental and occupational fields. Increasingly severe national and international air quality standards and exposure threshold limit values have been defined to protect the health of the general population and workers; this issue required a significant and continuous improvement in monitoring technologies to allow the execution of proper exposure assessment studies. One of the most interesting aspects of this field is the development of the “next generation” of airborne pollutants monitors and sensors (NGMS). The principal aim of this review is to analyze and characterize the state of the art and of NGMS and their practical applications in exposure assessment studies. A systematic review of the literature was performed analyzing outcomes from three different databases (Scopus, Pubmed, Isi Web of Knowledge): a total of 67 scientific papers were analyzed. The reviewing process was conducting systematically with the aim to extrapolate information about the specs, the technologies, and the applicability of NGMSs in both environmental and occupational exposure assessment. The principal results of this review show that the use of NGMSs increasingly common in the scientific community for both environmental and occupational exposure assessment to airborne pollutants. Available studies outlined that NGMSs cannot be used as reference instrumentation for regulatory purposes, but at the same time, they can easily be adapted to more specific applications, improving exposure

assessment studies in terms of spatiotemporal resolution, wearability, and adaptability to different types of projects and applications. Nevertheless, improvements needed to further enhance NGMS performances and allow their wider use in the field of exposure assessment are also discussed.

Keyword:air pollutants, sensor technology, exposure factors

1049230

Predicting long-term fine particulate matter exposures in the Puget Sound using a spatiotemporal model with low-cost sensor data

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Abstract: Epidemiological studies of the long-term health impact of fine particulate matter (PM2.5) air pollution rely on predicted long-term exposure estimates. Bias in the PM2.5 exposure estimates can affect inferences about estimated health effects. Few studies have evaluated the benefit of incorporating low-cost sensor data in long-term PM2.5 exposure estimates. As part of the Adult Changes in Thought Air Pollution study, we evaluated whether adding spatially dense low-cost sensor data from 105 cohort locations improves the spatiotemporal predictions compared to using only regulatory agency data from 28 locations and compared two types of co-located study-calibrated low-cost PM2.5 sensors (Plantower and Shinyei). We fit a hierarchical spatiotemporal model to data from 1978 to 2019 with and without the low-cost sensor data. We defined the regulatory agency data model as the Base model, the base data with the added Plantower data as the Plantower model, and the base data with the added Shinyei data as the Shinyei model. We report model performance during 2017 – 2019, the low-cost monitoring time period, using leave-one-site-out (LOSO) cross-validation (CV) at regulatory agency sites for long-term averages and 10-fold CV at low-cost monitoring sites for short-term averages. We found that including low-cost sensor data improved predictive accuracy of both long- and short-term averages compared to using regulatory agency data alone. On a long-term average time scale, the model with Plantower data performed better than a model with Shinyei or no additional sensor data, with a R_CV^2 of 0.79, compared to R_CV^2 of 0.78 and R_CV^2 of 0.66, respectively. RMSE values followed this pattern with the Plantower model RMSE = 0.59 μg/m3 , the Shinyei model with RMSE = 0.60 μg/m3 and the regulatory data only model with RMSE = 0.72 μg/m3. The long-term average model predictions also differ in their spread, with the interquartile range for the Base model being 1.16 μg/m3, 0.81 μg/m3 for the Plantower model and 0.70 μg/m3 for the Shinyei model. We conclude that for the Puget Sound region supplementing regulatory agency data with low-cost sensor data improves the performance exposure estimates intended to be used for epidemiological studies.

Keyword:air pollution, sensor technology, exposure models

1050856

Ultrafine Particle Exposure Among Adolescent Schoolchildren Across Microenvironments

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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 was to characterize personal UFP exposures experienced by adolescents with and without asthma. Methods: Participants (ages 13-17) were asked to complete two, seven-day sampling sessions using the PUFP C200 (Enmont, LLC) UFP monitor for 3 hours each day. The PUFP simultaneously records UFP concentration and GPS location at 1-second resolution. Measured UFP concentrations (p/cc) were assigned to one of four microenvironments using a spatiotemporal clustering algorithm ('circleclust'; R package) and proximity rules. Mobile activity identified by the algorithm were classified as 'transit.' Stationary coordinates were classified based on the proximity to participant defined locations: 'school' (300m) and 'home' (100m). Stationary coordinates not assigned to a specific location were classified as 'other.' We calculated exposure intensity, which we define as the summation of measured UFP concentrations within a specific microenvironment divided by the duration of time spent in that microenvironment (p/cc per second). We performed pairwise Wilcoxon test with Bonferroni adjustment to identify statistically significant differences across microenvironments. Results: A total of 116 adolescents participated, 62 of which completed two sessions. In total, 188 sampling sessions were recorded, amounting to 3,029 hours of personal UFP measurements with corresponding location data. The overall median UFP concentration was lowest at school (3,500 p/cc), while home (4,470), other (4,880), and transit (7,830) microenvironments were higher. The majority of UFP measurements were recorded at home (60%), followed by other (21%), transit (7%), and school (3%). Approximately 9% of the measurements could not be classified due to missing GPS information. Participants experienced an exposure intensity of 2,781 p/cc per second (Q1: 1,390; Q3: 4,940) at home, 2,204 (Q1: 993; Q3: 4,536) at other locations, 1,064 (Q1: 624; Q3: 1,689) at school, and 2,944 (Q1: 1,662; Q3: 5,261) in transit. Exposure intensity at school was significantly lower than other microenvironments ($p < 0.01$). Conclusions: Participants experience higher exposure intensities while in transit compared to other microenvironments. Fewer exposure sources and high efficiency filtration systems may contribute to lower UFP exposures at schools.

Keyword:particulate matter (PM), children, spatial

1051646

Characterizing temporal trends in ambient fine particulate matter, including COVID-19 impacts, using low-cost sensors in Grenada, West Indies

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Abstract: Background and Hypothesis: Routine measurement of ambient air quality is rare for most Caribbean nations, including Grenada. Previous studies have shown that exposure to ambient fine particulate matter (PM2.5) pollution, including Saharan dust particles, increases the risk of adverse cardio-respiratory outcomes. A pilot exposure study was undertaken in Grenada to better characterize temporal changes in ambient PM2.5 and assess the potential

for adverse health outcomes. Methods: Five fixed-site low-cost sensors (PurpleAir PA-II stationary monitors) were installed at fixed sites located in Grenada and one of its sister islands, Carriacou. These sensors provided continuous measures of ambient PM2.5 between January 6 and October 31, 2020. Additionally, meteorological data such as temperature, humidity, wind speed, and visibility were obtained from the Grenada airport. Regression analyses were performed to evaluate associations between ambient PM2.5 and meteorological variables, and contrast differences in PM2.5 concentrations between days with and without Saharan dust. Results: Daily mean concentrations of PM2.5 did not vary substantially by the day of the week (from a low of 4.1 ug/m3 on Saturdays to a high of 4.8 ug/m3 on Fridays). Daily mean ambient PM2.5 concentrations were significantly higher on Saharan dust days than non-Saharan dust days (8.9 ug/m3 vs 3.6 ug/m3, $p<0.05$), and during a major Saharan dust event in June 2020 PM2.5 reached a maximum daily mean of 20.4 ug/m3. Ambient PM2.5 concentrations were higher for the monitor situated closer to St. Georges (the main city in Grenada) than the other monitors which were situated in more rural settings. PM2.5 concentrations were lower on days where public health measures were implemented to reduce person-to-person spread of COVID-19 when compared to days where no such interventions were in place. Conclusions: This study provides data that corroborates that relative to other countries PM2.5 concentrations are generally low in Grenada. Nevertheless, spatial and temporal variations in PM2.5 across the island were observed and measurements of concentrations exceeding the WHO 24-hour mean guideline value were documented during Saharan dust events.

Keyword:air pollution, air quality sensor, COVID

1052335

Exposure Error—Filling the Gap with Indoor Measurements

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Abstract: All large-scale (multicity, multi-country) epidemiological studies of the effect of PM2.5 on health suffer from exposure error due to lack of long-term personal and indoor measurements. A major opportunity to partially fill this gap is now provided by the growing use of low-cost sensors to monitor indoor PM2.5. A popular low-cost monitor in the United States is PurpleAir (PurpleAir.com) with several thousand monitors in California. We have developed an independent method of determining PM2.5 from the numbers of particles in three size categories provided by PurpleAir (Wallace et al., 2021). We estimate long-term PM2.5 exposures using concurrent indoor and outdoor measures of PM2.5 over long periods (1-2 years). We first identify pairs of indoor and outdoor monitors within 500 m separation. We estimate the infiltration factor Finf using various regression methods. Outdoor concentrations are multiplied by Finf to determine exposure to particles of ambient origin. Subtracting this value from the measured indoor levels provides the indoor-generated PM2.5, an approximation of exposure error. This error is then plotted against outdoor air to identify the range of outdoor concentrations where the exposure error is substantial. The exposure error peaks at low outdoor concentrations of 2-5 micrograms per cubic meter and drops below 10% at outdoor concentrations near 20-30 micrograms per cubic meter. About 90 indoor monitors (11/1/18 to 6/30/20) were examined in an earlier study (Bi et al., 2021). A number of additional monitor pairs are analyzed here. Our approach depends on the assumption of

independence of indoor particle-generating activities from outdoor concentrations (Ott et al., 2000). We present multiple examples testing this assumption and give evidence detailing the extent of departure from our assumption. References Bi, J., Wallace, L., Sarnat, J.A. and Liu, Y. (2021) Characterizing outdoor infiltration and indoor contribution of PM2.5 with citizen-based low-cost monitoring data. Environmental Pollution 276:116793. DOI 10.1016/j.envpol.2021.116763 Ott, W., Wallace, L. and Mage D. (2000) Predicting Particulate (PM10) Personal Exposure Distributions Using a Random Component Superposition Statistical Model, J Air Waste Manage Assoc 50: 1390-1406. Wallace, L., Bi, J., Ott, W.R., Sarnat, J.A. and Liu, Y. (2021) Calibration of low-cost PurpleAir outdoor monitors using an improved method of calculating PM2.5. Atmospheric Environment, in press.

Keyword:particulate matter (PM), air sensor, other (specify below), exposure measurement

1052552

Human metabolism and excretion of naphthalene, fluorene, phenanthrene and pyrene after single oral administration

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Abstract: Introduction: Polycyclic aromatic hydrocarbons (PAHs), generated during incomplete combustion of organic matter, have health effects in multiple organs and can cause lung, skin and bladder cancers in humans. After absorption via ingestion or inhalation, they are metabolized into hydroxy-PAHs (OH-PAHs) and excreted in urine (mainly low-molecular-weight PAHs) or feces (mainly high-molecular-weight PAHs. Despite the large number of toxicological studies, information on PAHs absorption-distribution-metabolism-excretion (ADME) is very limited in humans. Methods: A single dose deuterium-labeled naphthalene (Nap), flourene (Flu), phenanthrene (Phe) and pyrene (Pyr) were administered at 0.02~0.04 mg/kg in 9 healthy adults. Then, serum and urine samples were collected at designated time for 72 hours after oral exposure. Parent compounds and about ten metabolites were measured by HS-SPME-GC-MS and LC-MS/MS, respectively. (* Seoul National University Institutional Deliberation Committee IRB No.2009 / 003-034). Results and Discussion: Finally, six subjects (age: 33.7 ± 8.8 years) without missing samples were participated finally. The highest concentrations (Cmax) were 13.8 nM for Nap, 4.03 nM for Flu, 0.70 nM for Phe and 2.19 nM for Pyr in serum. The highest concentration times (Tmax) ranged between 0.25 and 1.42 hours showed that the larger the molecular weight, the larger the tendency. The half-life (T1/2) in serum was within 0.5 hours and the mean resident time (MRT) was 2.1 to 3.4 hours. The 72-hour fractional urinary excretion (Fue) of each parent compound was 0.023% for Nap, 0.001% for Flu, 0.013% for Phe, respectively, while Pyr was not detected in urine. Fue of total urinary OH-PAHs were 1.87% for OH-Nap, 9.79% for OH-Flu, 3.45% for OH-Phe, and 12.2% for OH-Pyr. The excreted amounts of parent compounds and OH-PAHs in 24 hours after oral administration reached 81.0% (Nap), 87.8% (Flu), 89.3% (Phe), and 95.1% (Pyr) of those in 72 hours. Conclusions: Nap, Flu, Phe and Pyr reached maximum serum levels shortly after exposure followed by decreases in about half an hour. Most of them excreted within 24 hours after exposure in the form of metabolites rather

than the parent compound. Suggestively, PAH and OH-PAHs excreted via other than urine (e.g. feces). The Fues of key metabolites of PAHs in urine were obtained in the present study, which could be useful in estimating the average daily intake (or oral-equivalent) amounts of PAHs among general populations.

Keyword:metabolism, dose, risk assessment, Polycyclic aromatic hydrocarbons (PAHs), Oral administration, Metabolism, Excretion Fractional urinary excretion (Fue)

1052787

Methods for evaluating urban heat experience and exposure in environmental justice communities during a period of physical distancing.

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Abstract: Background The rising frequency of extreme heat events necessitates increased focus on mitigation of heat-related health impacts. Vulnerable populations in urban heat islands may have personal exposures that differ from ambient temperature, but these are challenging to characterize, especially when researchers have limited access to participant's homes. Objective Use remote methods to characterize the experience of heat events during summer 2020 in two environmental justice communities in Massachusetts, US. Methods We conducted remote interviews to assess participants' heat vulnerability and adaptation strategies, and distributed Bluetooth-enabled low-cost sensors that captured location, temperature, relative humidity, heart rate, sleep quality, and physical activity. We developed Python scripts and Microsoft Azure FunctionApps to retrieve and examine data quality in real time. Results Twenty two residents consented and completed the study. Participants were 22 to 78 years old, 55% spoke Spanish and 50% were foreign-born. We captured and verified 82% of expected location observations, greater than 74% of expected biometric observations, and over 93% of expected meteorological observations. Significance We demonstrated the feasibility of remote methods in collecting qualitative and quantitative exposure data. These methods are applicable to other studies in resource-limited or physically distant settings, and serve to contextualize adaptation strategies with participant experiences.

Keyword:climate change, thermal environment, sampling methods

1053248

Using Personal Air Sensor and GPS to Determine Microenvironment-specific Exposures to Volatile Organic Compounds

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National Institute of Environmental Health Sciences

Abstract: Human exposure to volatile organic compounds (VOCs) from indoor sources including consumer products is a public health concern that is understudied. For a 10-day pilot study to demonstrate methods for determining VOC exposures, we examined time-resolved sensor-based measurements of geocoded total VOC (TVOC) exposures across individuals and microenvironments (ME). We integrated continuous (1-min) data from a personal TVOC sensor and a global positioning system (GPS) logger, with a GPS-based ME classification model to determine TVOC exposures in four ME, including indoors at home (Home-In), indoors at other buildings (Other-In), inside vehicles (In-Vehicle), and outdoors (Out) across 45 participant-days for five participants. To examine potential exposure factors when Home-In, we applied a residential air exchange rate (AER) model based on building characteristics and weather conditions. To help identify large emission sources, we identified high exposure events (HEE; TVOC > 500 ppb) and used geocoded TVOC time-course data overlaid on Google Earth maps to determine the type of place visited. For HEE when Home-In, we estimated TVOC emission rates and removal rates with a dynamic mass-balance model. The ME ranked from highest to lowest median TVOC were: Home-In (165 ppb), Other-In (86 ppb), In-Vehicle (52 ppb), and Out (46 ppb). For the two participants living in single-family houses with attached garages, the median exposures when Home-In were substantially higher (209, 416 ppb) than the three participant homes without attached garages: one living in a single-family house (129 ppb), and two living in apartments (38, 60 ppb). The daily average Home-In exposures exceeded the LEED building guideline of 108 ppb for 60% of the participant-days. For the daily residential AER, the medians were lower for the homes with attached garages (0.04, 0.07 /h) than the homes without attached garages (0.19, 0.23, 0.29 /h), which corresponded to days with smaller and larger indoor-outdoor temperature differences, respectively. We identified 94 HEE across all participant-days, and 67% of the corresponding peak levels exceeded 1000 ppb. The ME ranked from highest to lowest number of HEE were: Home-In (60), Other-In (13), In-Vehicle (12), and Out (9). Our study demonstrates the ability to determine individual sensor-based time-resolved TVOC exposures in different ME, in support of identifying potential sources and exposure factors that can inform exposure mitigation strategies.

Keyword:air sensor, exposure models, VOCs

1053987

Facilitating Population-Level Studies by Using Housing Characteristics to Predict Household Levels of PM2.5

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Abstract: Exposure to ambient air pollution increases the risk of hospitalization and mortality and can prolong the duration of critical care encounters. However, indoor air quality differs from outdoor air quality, which can be a substantial exposure considering individuals spend much of their time indoors. Ascertaining indoor air quality can be difficult over large populations and intrusive at the individual level. Methods for estimating household air pollution levels could fill an information gap that currently exists and prohibits conducting

population-level studies that aim to understand the impact of indoor air pollution on health outcomes. To better understand the impact of household indoor air quality on human health, we will develop models for estimating levels of particulate matter with a diameter less than 2.5 μm (PM2.5) in homes within Utah, USA. Metropolitan areas of Utah experience high variability in ambient air quality throughout the year, thus creating a unique environment for high-impact research. Machine learning methods will be used to derive models that predict PM2.5 levels across different time frames, e.g. weekly, quarterly, and yearly. Model development will rely on publicly available data from PurpleAir indoor PM2.5 sensor data, Environmental Protection Agency (EPA) air quality data, weather data, and housing characteristics. Intermountain Healthcare datasets will be used to validate models and conduct population-level studies. Intermountain research datasets contain housing characteristics and PurpleAir sensor data, which will be used for model validation, while the data warehouse contains information on over 2.2 million patient encounters in 2019. Means square error (MSE) and mean absolute error (MAE) will be used to validate predictions of continuous levels of PM2.5, while accuracy, precision, recall, and F1-score will be used to assess threshold-based models (thresholds based on EPA and World Health Organization recommendations). Once models that predict household PM2.5 are validated, they will then be applied to geographic areas served by Intermountain and used to evaluate the impact of household PM2.5 on health outcomes (e.g. readmissions, mortality), including those relevant to critical illnesses (e.g. intensive care unit length of stay, duration of mechanical ventilation) using Intermountain's data warehouse.

Keyword:air quality, exposure models, built/indoor environment

1054025

Monitoring Human Exposure to Organophosphate Esters: Comparing Silicone Wristbands with a Spot Urine Sample

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Abstract: Silicone wristbands present a noninvasive exposure assessment alternative to traditional biomonitoring; however, questions about their utility remain as validation studies are limited. We sought to determine if wristbands provide quantitative estimates of organophosphate ester (OPE) exposure. We evaluated total OPE exposure in a convenience sample of 10 adults by measuring total metabolite masses excreted in urine over 5 days. During the same period, study participants wore multiple wristbands (removing one each day) and collected daily spot urine samples. We assess both measures as surrogates for total exposure. Of the 34 OPEs evaluated on wristbands, 24 were detected on at least one band. On Day 1, triphenyl phosphate (TPHP) was detected on all bands; however, by Day 5, 10 compounds were detected on all band. Tris-(2-chloroisopropyl)phosphate (TCIPP) was detected at the highest concentrations on wristbands (median=282 ng/g) followed by tris-(1,3-dichloro-2-propyl)phosphate (TDCIPP) and TPHP (median=176 and 172 ng/g, respectively). OPE uptake on wristbands was generally linear over time, with daily uptake rates from 0.32 to 53.35 ng. These data have important implications for understanding how wristbands function and comparing measurements across studies. Three OPE metabolites were detected in >98% of urine samples, with diphenyl phosphate (DPHP) detected at the highest median concentrations. DPHP is a non-specific metabolite of several OPEs. Neither DPHP in spot

urine nor any OPE parent compounds evaluated on wristbands was correlated with total DPHP excreted in urine, which may be due to the range of possible parent compounds and potential for dietary exposure. However, wristbands TDCIPP and TCIPP were moderately correlated with total excretion of their primary urinary metabolites, BDCIPP and BCIPHIPP, respectively ($rs>0.65$, $p<0.04$). These data suggest wristbands, worn for 5 days, provide a reliable and quantifiable measure of exposure to TDCIPP and TCIPP. Spot urine samples were also moderately correlated with total exposure, suggesting they also capture short-term exposure information. While limited, these data suggest that wristbands are just as reliable as spot urine samples in evaluating exposure to TDCIPP and TCIPP. Given the potential advantages of wristbands for researchers and study participants, further studies investigating additional compounds are needed to determine their utility in predicting exposure for rapidly metabolized chemicals.

Keyword:SVOCs, biomonitoring, flame retardants

1054078

Improving exposure assessment by using data from low-cost wearable airborne particulate matter sensors for complex activity recognition

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Abstract: Elevated levels of airborne particulate matter can be closely associated with a specific activity (e.g., smoking, cooking) or environment (e.g., busy road) [1]. Applied to data from low-cost wearable sensors, machine learning can be used to recognize specific activities (simple and complex), without resorting to manual data logging. Research has shown promising results for recognizing simple activities, such as walking and running, but reliable recognition of complex activity is still elusive [2]. Wearable movement/heart rate, and particulate matter/temperature/humidity sensors were used with two groups of individuals, who recoded activates they were performing through the day: - group A recoded activities (e.g. “cooking”, “cleaning”, “running”, etc.) with hourly resolution, as part of the ICARUS H2020 project [3], - group B recorded activities with minute resolution. The dataset from group A was modelled with three classification algorithms (k-nearest neighbours, decision tree, random forest tree ensemble), with results of correctly classified instances being 32.7%, 39.5% and 43.1%, respectively. Most misclassifications were observed for activities with vague definitions, such as resting and playing, and fewer for better defined activities, such as smoking and cooking. We anticipated accuracy could be improved by a clearer definition of activities, breaking more general activities into more specific ones, and increasing temporal resolution. These improvements were implemented for group B, where preliminary results showed improved results with accuracies >60%. This research is a first step that indicates the usefulness of combining wearable particulate matter and activity sensors for complex activity recognition as aid in exposure assessment. [1] S. Vardoulakis et al., ‘Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review’, doi: 10.3390/ijerph17238972. [2] M. Shoaib et al., ‘Complex Human Activity Recognition Using Smartphone and Wrist-Worn Motion Sensors’, Sensors, doi: 10.3390/s16040426. [3] ‘ICARUS2020.eu’. https://icarus2020.eu/.

Keyword:particulate matter (PM), activity patterns, other (specify below), machine learning

1054133

Differentiating Ultrafine and PM2.5 Exposure Patterns Through Personal Monitoring Using Wearable Sensors

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Abstract: Evidence from experimental toxicology studies suggest that ultrafine particles (UFP) play a significant role in particulate matter (PM) respiratory toxicity due to their high potential to transport toxicants via a large number concentration and surface area per unit mass as compared with larger particles. However, this has not been validated in epidemiological settings mainly because accurate, directly measured exposure data are not readily available. Our study includes a person-level exposure assessment of asthmatic adolescents using wearable UFP and PM2.5 sensors (Enmont PUFP and RTI MicroPEM, respectively). Our approach also integrates data from biometric sensors and mobile data collection tools to differentiate exposure patterns and inhaled doses to examine potential impact on lung function variability. Sensor performance and operability was tested before field study to ensure the data quality of the sensors. When challenged with a wide range of particle concentrations (up to 62000 particles/cm3), PUFP showed a linear increase and no plateau at high concentrations. When compared with a high-precision reference instrument (SMPS, TSI inc.), a high degree of linearity was observed between SMPS and PUFP with the coefficient of determination (R2) of 0.96 or above. Precision between the PUFPs was excellent with the mean relative percent difference of 96.9%. We simulated participants' activities, including studying, cooking, and opening windows while measuring PM concentrations using both the PUFP and MicroPEM. Both sensors operated without interruption and continuously measured PM concentrations in dynamic ranges during the monitoring time. UFP and PM2.5 concentrations drastically increased from a few thousand to 280000 particles/cm3 and from 25 to 800 ug/m3, respectively, within few minutes when activities changed from studying to cooking scenarios. When forced hot air was turned on after not being used for an extended period, the PM2.5 level went up to 1000 ug/m3, oscillating with heating cycle while UFP level did not change, indicating different exposure patterns between UFP and PM2.5. Wearable sensors can provide high resolution, accurate personalized measurement data that support robust exposure assessment, which central site monitors or land use models can not provide. This novel research approach will provide insights into distinct and joint effects of varying size fractions of PM on lung function changes.

Keyword:particulate matter (PM), air quality sensor, other (specify below), Personal monitoring

1054216

Application of low-cost, commercially available, wearable particulate matter sensors

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Abstract: Background Low-cost, wearable PM sensors claim to measure air quality with a high spatiotemporal resolution, which could improve exposure assessment in epidemiological studies on air pollution and health. Exposure during commutes or indoor/outdoor leisure activities is difficult to accurately estimate with models and activity diaries. For some health endpoints, short-term fluctuations or peak concentrations could be more relevant than annual average concentrations at an address. High resolution data from PM wearables can be linked to acute bodily responses, or used to identify high vs. low exposure activities and hotspots. We investigated the performance of different PM wearables, and their potential for epidemiological research. Methods Five commercially available PM wearables were purchased in triplo: AirBeam2, Atmotube PRO, Plume Labs Flow 2, Wynd Air Quality Tracker and Nova Fitness SDL607. Devices were placed at two national air quality monitoring stations (reference) for several consecutive days (June/July 2020). Measurement intervals varied per type: 1 sec. - 5 min. All provided PM2.5 data, which was the main interest as respirable fraction linked to several health effects. Agreement (spearman correlation) between and within wearable types was investigated (5 min. averages), and with hourly reference data. Results The AirBeam was omitted from analysis due to missing data. For PM2.5, high agreement (>0.90) between devices was found for Atmotube, Wynd and SDL607, while Plume only correlated moderately (0.50). Agreement with reference data was overall poor to moderate. In some cases, wearables detected peaks in PM2.5 that did not show in the hourly reference data. Discussion High agreement for PM2.5 was found within and between the Atmotube, Wynd and SDL607 wearables. Agreement with reference data was limited. Some short-term peaks did not appear in the (hourly) reference, but were consistently detected by several wearables. Their absolute measurement value might not precise, but these PM wearables showed consistent and repeatable patterns, indicating that they can distinguish high vs. low exposure situations at a high temporal resolution. Missing data and/or connection problems occurred for several devices, and unknown internal calibration algorithms can be considered an issue for application in scientific research. Based on several (user) parameters, the best performing wearable(s) will be further investigated and applied in volunteer experiments.

Keyword:particulate matter (PM), sensor technology, air pollution

1054275

Assessment of Respiratory Symptoms in Children using Exposures from a Low-Cost Sensor Network and a Message-Based Reporting System

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Abstract: Epidemiological studies have reported adverse effects of air pollution on the exacerbation of respiratory diseases in children and adults. Previous studies have indicated that PM2.5 may play a role in triggering asthma symptoms, but findings have not been consistent. Many ambient PM2.5 exposure studies have used only a few regulatory monitors

to estimate ambient PM2.5 for an entire urban area, which likely fails to accurately characterize the true heterogeneity of exposure. Recent advances in low-cost sensing technologies have enabled researchers to collect measurements of ambient PM2.5 at increasingly higher spatiotemporal resolutions. We installed 45 low-cost PM2.5 sensors in Baltimore, Maryland, USA, where little is known about the variability of air pollutants throughout the city. To investigate the association between changes in PM2.5 concentrations and respiratory symptoms, we asked an established cohort of asthmatic children to report symptoms, such as wheezing or use of an inhaler, by surveys sent to their personal phones or email twice a day for one week. This novel symptom reporting system enables participants to report symptoms near real-time, which likely reduces recall bias, and reduces participant burden compared to traditional paper-based time activity diaries. We observed a high compliance rate of about 11 out of 14 surveys completed per participant, and participants reported experiencing symptoms on 42% of their sample days on average (38 of 75 participants recruited to date). We then estimated the ambient PM2.5 concentrations for each participant's home using optimal spatial interpolation from the high-resolution monitoring network using hourly averages. In this presentation, the spatial and temporal distribution of PM2.5 in the Baltimore area will be discussed, as well as the results of regression models used to determine the relationship between ambient PM2.5 concentrations and the presence of symptoms. In addition, an evaluation of this relationship using participant-specific ambient concentrations estimated from the high-density network compared to using the single ambient PM2.5 regulatory site in the city for all participants will be presented.

Keyword:air pollution, air quality sensor, geospatial analysis/GIS

1054333

Wearable technology measures personal radiation exposure, from ultraviolet to infrared

Z. Sherman; Scienterra Ltd.

Abstract: New technology enables real-time exposure monitoring of six wavebands of radiation, plus physical activity and pedometry. Research-grade radiation measurements of UVB, UVA, blue, green, red, and broadband white light are relayed to a smartphone app and cloud database. The smartphone app is designed to be practical and educational, allowing users to gain control of their own exposure. The cloud database allows remote monitoring of at-risk populations (e.g. outdoor workers, melanoma survivors) for the purpose of ensuring health and safety by reducing incidences of skin cancer. Skin cancer is New Zealand's most commonly occurring cancer, costing the national health system $180M per year for diagnosis and treatment. In a country of only 4 million people, 500 annual deaths is a terrible social burden. Between 65% and 95% of melanomas and 99% of keratinocytic cancers could be prevented by reducing population exposure to ultraviolet radiation. Education has been important for skin cancer prevention, but more action is needed. In the past decade, most research has focused on erythema, DNA damage, and vitamin D synthesis linked to UVB exposure. UVA exposure is also a recognized carcinogen, but less data is available. New research on blue light exposure, and its role in melatonin suppression, have caused concern about health and safety of night-shift workers. Green light, matching the photopic eye response, is important in ophtalmology. Accurate accelerometry data helps to deconvolve radiation exposure, physical activity, and health. The technology presented here enables

researchers, health agencies, regulatory agencies, schools, and the general public to benefit from current knowledge, while contributing data to help researchers better understand how these exposures are interrelated.

Keyword:sensor technology, radiation, cumulative environmental effects

1054393

Contextual information in support of occupational health risks monitoring

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Abstract: The digital transformation that is currently happening across multiple sectors of industry is primarily driven by the prospect of enhanced process operations. Large amounts of information are being generated by sensors embedded in equipment and processes and exchanged autonomously to maximise efficiencies between production, distribution and the supply chain. This digital transformation also extends to the workforce, with the emergence of new capabilities based on the use of smart sensing devices small enough to be worn comfortably and able to wirelessly connect to a network (i.e. wearables). These sensing devices make it possible to collect continuously and remotely both process-related and personal time-resolved data, but also to feedback information to the wearer without the need for the presence or intervention of an exposure specialist for collecting samples, monitoring activities and reporting observations in physical diaries. In order to interpret the time-resolved data collected on respirable dust the capture of high resolution contextual information about processes and activities is needed, e.g. using videos, positioning and environmental monitoring (e.g. noise) technologies. In this presentation, we will present a few examples of contextual information and related technologies (video, positioning and noise technologies) used to complement time-resolved sensor data but which might also be used on their own to monitor health risks. Examples will be selected from work undertaken at NIOSH, TNO and HSE in mining, bakeries and in the context of COVID.

Keyword:occupational exposure, sensor technology, other (specify below), indoor positioning

1054437

TNO, HSE and NIOSH partnership on applying the exposome concept to occupational health

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Abstract: The Netherlands Organisation for Applied Scientific Research (TNO), the Health

and Safety Executive (HSE) in Great Britain and the United States National Institute for Occupational Safety and Health (NIOSH) have established a formal partnership to engage in collaborative research. This collaboration aims to advance the protection of workers and to promote best practices to improve worker safety and health by applying the exposome concept on occupational health. TNO, HSE and NIOSH (the Partnership) have identified several areas of research where shared interests, knowledge and cooperation can improve worker safety and health to a greater extent than any one agency may succeed. One area of research is the development and evaluation of new measurement methods capable of collecting more complete or more individual-level exposure data, e.g. sensors or point of care biomonitoring assays. The Partnership has identified a need for a standardized approach to calibration, evaluation of performance, data analysis and interpretation for wearable monitors, especially low cost monitors for particulates, gas and vapors. The initial cooperative effort has developed guidelines for evaluation of low-cost particulate matter monitors and has been applying these guidelines to evaluate performance of several low cost sensors in each individual laboratory and in field studies. This effort will ultimately guide practical applications for conducting worker exposure assessments with wearable monitors. These innovative direct-reading approaches can provide large volumes of highly time-resolved data on worker exposures to respirable particulates identifying situations and locations (when combined with positioning technologies) with elevated exposures and can guide the improvement and evaluation of dust control technologies in workplaces where the respirable dust may be highly variable. In this presentation, the Partnership is introduced and the goals of the collaboration are explained, followed by three in-depth contributions of work conducted.

Keyword:air sensor, aerosol, industrial hygiene

1054477

Global Positioning System (GPS) Assessments of Green Space Exposure and Use

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Abstract: We use stand-alone and cell-phone application measures of geographic location at multiple collection frequencies to assess exposure to green space. The study relies on the PASTA LA study which measured 441 participants with both commercial GPS and cell-phone apps. We characterize the activity space for all participants using five approaches, and discuss the comparability of these approaches using statistical comparison tests and graphic visualizations.

Keyword:exposure models, GIS, environmental health

1054487

Refining PM exposure using low-cost portable sensor data and human respiratory tract deposition modelling

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Abstract: The current work presents the results of a personal exposure assessment methodology, which involved a personal sensor campaign, aiming to refine PM exposure using low-cost portable sensor data, exposure and human respiratory tract deposition modelling. A custom-made monitoring device was developed for measuring 3 fractions of PM (1, 2.5 and 10 μm), enabling direct assessment of personal exposure. The device is based on an Arduino microcontroller where small sensor-modules are connected. In order to improve sensor performance, correction factors were used accounting for diverse environmental conditions, parameterised against measurements of a well validated light scattering optical sensor. In addition, participants wore a physical activity wristband (Garmin Vivosmart 3) that records steps, distance, type of activity, heartbeat and sleeping patterns. Finally, participant positions were recorded using a GPS sensor, integrated into the PM sensors. After validation, the sensors were used to capture daily variability of PM exposure for the participants. Exposure was further refined by estimating inhalation adjusted intake rate, as well as PM deposition across human respiratory tract (HRT) using the Multiple Path Particle Deposition (MPPD) model. The above methodology was applied in the personal sensors campaign of the HORIZON2020 EU Project ICARUS, where exposure and intake to PM of almost 100 individuals was monitored. The integrated methodology outlined above, allowed us to significantly differentiate the actual intake of the participants, highlighting larger differences than the ones attributed to the spatial differentiation of the fixed station air pollution (difference of ambient PM levels of 50% were translated in intake differences up to 110%). These differences are the result of the differences in PM size fractions that are captured by the sensors and the capability of the HRT model to translate the differences in PM size distribution accounting for the differences in physiology among the participants, finally reflected in intake estimates. Overall, integration of sensor data with advanced exposure models allows us to significantly differentiate the actual intake to PM among individuals, at levels that are not conceived based on the spatial distribution of air quality monitoring, or among people of different age and activity patterns.

Keyword:air quality sensor, fine particlate matter, exposure models

1054542
Quantification of factors influencing indoor air quality exposure in rural Indian households using a low-cost sensor network approach

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Abstract: Indoor air quality has been identified as one of the most significant environmental health risks according to the World Health Organization (WHO). In typical rural households in India, daily activities like cooking and space heating using thermally inefficient ovens and solid biomass fuels contribute to most of the emissions in the indoor microenvironment. There are currently gaps in our understanding of the relative influence of different drivers of

pollutant concentrations inside rural households. While variations in fuel type/stoves and kitchen type are the major factors affecting indoor pollutant exposure, housing arrangement and household practices that influence the ventilation of indoor spaces can also play a crucial role in exposure and are often overlooked. The COVID-19 pandemic is an illustrative example of the potential importance of ventilation. Studies have identified that poorly ventilated rooms/ houses can also contribute to viral spread due to aerosol transmission. Prioritizing adequate ventilation in buildings and households can reduce the risk of viral transmission and alleviate pollutant exposure and support healthy living. In this study, a network of low-cost sensors (RAMP = Real-time, Affordable, Multi-Pollutant) was deployed at two villages (14 households) in Uttar Pradesh, India, to collect spatio-temporal indoor and ambient PM and CO concentrations for 6 weeks in wintertime. Campaign RAMP data were post-processed based on a calibration model developed for individual RAMP sensors from a field deployment with reference grade instruments. RAMP and survey data from this campaign were used to quantify ventilation characteristics (Air Exchange Rate, AER), building characteristics, and emission rates for different fuel and stove combinations. Using decay regression analysis following cooking events, we estimated the average AER for each kitchen type using PM2.5 and CO as tracers. Our preliminary results from 4 households show that the mean concentration of PM2.5 was 4-6 times higher during cooking periods than non-cooking periods. Median AER values for households ranged from 0.5-1.0 hr-1, significantly lower than the recommended levels (3 hr-1 as per IS:3362-2004). Using these real-world estimates, we build a box model which can be used to predict indoor air pollution exposure based on emission sources and building characteristics, where actual measurement is missing.

Keyword:ventilation, air quality sensor, built/indoor environment

1054547

In laboratory calibration and evaluation of a selection of PM monitors to be used for monitoring occupational exposure.

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Abstract: In recent years, the Exposure Science community has demonstrated interest in the use of small, lightweight, low-cost optical particulate matter (PM) monitors that facilitate the simultaneous monitoring of multiple areas throughout the workplace. The accuracy of the measurement generated by these devices is an important aspect and a topic of concern to understand how the data generated may be used effectively. The creation of a standard method for the comprehensive evaluation of the performance of low-cost PM monitors would provide professionals greater confidence on the use, selection and adoption of the technology. This presentation will report the rational for the investigation of guidelines for laboratory testing of low-cost PM monitors to be used in occupational environments. Several factors were considered: type of dust, within- and between-device variations, nature of the power supply, temperature, relative humidity, and exposure pattern (peak and constant). The guidelines were applied in a series of laboratory testing conducted at Netherlands

Organisation for Applied Scientific Research (TNO) and initiated at United States Nation Institute for Occupational Safety and Health (NIOSH) and the in Great Britain on six PM monitors. Each factor was tested and analysed individually and, if found to affect the readings significantly, included in a final correction model specific to each monitor. The contribution will present the results of the laboratory testing with particular focus on the average accuracy of the measurements after a correction model is applied. The testing has showed a high degree of variability in performance among the un-corrected monitors when challenged with the same type of dust which indicated the need for a monitor specific correction model.

Keyword:occupational exposure, sensor technology, air quality sensor

1054565

A newly developed particulate matter monitor (UPAS v2+) and a potential approach for identifying different particulate matter sources and improving average gravimetric correction factors for estimating continuous fine particulate matter exposure levels.

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Abstract: Low-cost light scattering devices for particulate matter can improve understanding of spatial and temporal patterns in particulate matter concentrations, but calibration is critical for accurately assessing these patterns. One calibration method is co-location with integrative filters that allow an average gravimetric correction factor (GCF = net mass on filter/average low cost sensor response) to be applied across each deployment. However, variations in optical properties of different particle sources can insert errors on short term responses of the sensor even though this traditional GCF method provides the correct average response. A newly developed air monitor (UPAS v2+) from Access Sensors uses a PM sensor employing algorithms which estimate counts and mass concentrations in different PM sizes as well as estimating the “typical particle size” in µm. Additional sensors measure T, RH, light intensity and accelerometer parameters. The air monitor also collects integrative filters for specific sized PM, allowing a calibration for each deployment. Traditional GCFs for PM2.5 ranged in values by more than a factor of 3 for ambient and NYC subway deployments. Additional samples await filter weighing for GCFs from emissions from wood chip stoves and combustion chambers. 30 second average PM2.5 levels during subway deployments ranged from 20 to over 800 µg/m3, based on traditional average GCFs. The NYC subway system is complex and has large spatial and temporal variations in PM2.5; Cars and stations in different subway lines exhibit concentrations more than 10x median measured values in the subway environment. One second data allows one to see dynamic changes including contaminant transport traveling via piston flow ventilation and how air filtration efficiencies in the subway cars vary dramatically depending on subway line. We will show how the “typical particle size” parameter together with the concentration data and other collected parameters can distinguish between sources from above ground ambient PM2.5, below ground metal rich PM2.5, and when diesel train emissions dominate below ground on subway platforms. This approach allows a mass balance method to partition the average GCFs for ones that more accurately estimate PM2.5 levels for different portions of the deployment period. The importance of collecting sufficient field blank filters in low flow rate personal samplers for

reducing errors in gravimetric correction ratios will also be discussed.

Keyword:air quality sensor, particulate matter (PM), sensor technology

1054625

Ambient, indoor or personal? Capturing extreme heat exposure and characterizing risk factors in an environmental justice community.

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Abstract: Background Heat exposures experienced by urban populations in outdoor and indoor urban environments pose a significant public health concern and are increasing due to climate warming trends. Although studies have linked ambient temperature to health, growing evidence suggests that ambient temperature does not capture the full experience of heat. People spend most of their time indoors, and the physical distancing guidelines of the Covid pandemic increased the amount of time spent at home. Additionally, little is known about the risk factors for extreme heat indoors. Characterizing indoor, outdoor, and personal exposures, as well as their relationship to the built environment is necessary to capture the full experience of heat and identify potential interventions. Methods We conducted this study in Chelsea and East Boston, two environmental justice communities in Massachusetts, US. Over 6 weeks in the summer of 2020 we recruited 22 residents and measured outdoor, indoor, and personal temperature and relative humidity using low-cost Bluetooth sensors (HOBO MX1101). We estimated hourly heat index (HI) (National Weather) and linked it to geocoded residential addresses, questionnaire data (AC use, floor of residence, occupancy number), and a geospatial database of housing characteristics, land use, and satellite data. We then built statistical models exploring the relationship between potential predictors including housing age, type, construction materials, air conditioning (AC) use, neighborhood greenness, impervious surface, and housing density. Results On the hottest week of the summer, the hourly mean HI was 74 (range: 63 - 104), 77 (range: 60-93), and 78 (range: 64-125) °F, for outdoor, indoor, and personal sensors, respectively. Outdoor HI was correlated to land use characteristics such as impervious surface and greenness. Although all homes had AC, indoor hourly mean HIs exceeded the 75-80.5 °F comfortable indoor temperature range on all hot weeks in homes with window and wall AC but not central AC. Personal hourly mean HI was higher than indoor 57% of the time and indoor hourly mean HI was higher than outdoor 85% of the time. Conclusions Given observed differences between personal, home, and ambient exposures, these results demonstrate the importance of characterizing heat exposure with all three metrics. Results identify potential avenues of intervention at a housing and neighborhood level to reduce extreme heat exposure in vulnerable residents.

Keyword:climate change, thermal environment, environmental justice

1054635

Comparison of time-resolved personal and residential PM2.5 mass concentration in school-aged children

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Abstract: The Domestic Indoor Particulate Matter and Childhood Asthma Morbidity (DISCOVER) study was a longitudinal cohort study of school-aged children aged 5–12 years in Baltimore, Maryland with physician-diagnosed asthma. Time-resolved PM2.5 concentration, relative humidity, and temperature data from 193 participants were collected during 4 measurement periods (baseline, 3 months, 6 months, and 9 months). During each one-week evaluation period, air monitoring equipment was placed inside the room where the child slept, and the participants were asked to concurrently carry a backpack with monitoring equipment for 7 days to measure personal exposures to PM2.5. The goal of this work was to compare the area and personal monitoring data to assess how representative area measurements are for a child in that household. Overall, personal PM2.5 concentrations were greater and more variable (personal 24-hr average = 30.3 ± 100.2 μg/m3; area = 23.4 ± 21.2 μg/m3), and the 95th percentile concentration for a sample day was higher for personal measurements compared to area measurements (127.4 ± 590.2 and 80.6 ± 100.6 μg/m3, respectively). Overall, the hourly personal and area measurements were highly correlated (r =0.81), and the correlations were higher overnight (7 pm-7 am; r = 0.86) compared to the daytime (7 am-7 pm; r=0.77). These trends remained consistent through several visits. While personal monitoring is more burdensome for a participant, these results suggest that area measurements may not capture the range of concentrations an individual is exposed in a typical day. Since peak concentration may be more directly relevant than daily averages to acute respiratory health effects, personal monitoring approaches are likely advantageous in studies focusing on assessing health outcomes.

Keyword:sampling methods, air pollution, fine particlate matter

1054646

Application of unmanned aerial vehicles to assess the quality of urban greenspaces

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Abstract: Background Urban greenspaces, an important neighborhood characteristic, are associated with human health. However, little research focused on the objective measure of the quality of greenspaces. We aimed to prove the concept of an objective assessment on the quality of greenspaces using an unmanned aerial vehicle (UAV, aka “drone”) in two suburban parks with subsequent geospatial analysis. Methods We flew a UAV (DJI Phantom 4) with an RGB camera and the same settings to collect imageries 60 meters above two parks with similar landscapes but different socioeconomic status (SES) backgrounds (high vs. low) in the suburb of Los Angeles. We processed the images through Pix4D to create two orthomosaic maps of the two parks. We created 20 training samples per map for four types of landscape features: healthy grass, unhealthy grass, trees, and other land covers based on visual inspection and RGB band values in ArcGIS. These landscape features were applied to the whole map in maximum likelihood regression models. Greenspace quality was calculated

as the ratios of the healthy grass to unhealthy grass or the whole area. Results The two parks were similar in size (62,567 vs. 68,819 m2), but the high-SES park had more land covered by healthy grass (18,904 vs. 8,626 m2) and trees (22,957 vs. 16,354 m2) and less by unhealthy grass (8460 vs. 10,896 m2) and buildings (18,498 vs. 26,690 m2) than the low-SES park. The ratio of healthy grass cover to all grassland cover was higher in the high-SES park (69.1%) than the low-SES Park (44.2%), although the ratios of all grassland cover to overall land cover were compatible (39.8% in the high-SES park vs. 31.2% in the low-SES park). Conclusions Our study indicated the utility of unmanned aerial vehicles in the assessment of greenspaces quality. We also found that the quality of greenspaces could be different in greenspaces with similar sizes and landcover features.

Keyword:built/indoor environment, geospatial analysis/GIS, spatial

1054664

Testing the efficacy of a low-cost air pollution monitoring device for occupational exposure measurements: A pilot study

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Abstract: The development of new low-cost air sensors has expanded the field of air quality surveillance due to the reductions in entry cost; however, some previous studies have demonstrated potential limitations to their abilities. Low-cost Particulate Matter (PM) sensors have been used for environmental sampling, but they are yet to be used to measure worker exposures in occupational settings. A smaller and affordable unit will enable sampling of more individuals at a workplace and have a lesser impact on worker behavior, compared to the larger and more expensive monitors currently used. Therefore, this study aimed to test the efficacy of a selected low-cost air sensor, the Airbeam, in comparison with a more advanced nephelometric device and industry standard; the Thermo Scientific PDR 1500 Data RAM. Both the Airbeam and the PDR 1500 use light scattering to determine the amount of particulate matter in the air. However, when taking measurements, the PDR 1500 uses a physical cut cyclone while the Airbeam uses an algorithm to determine the size distribution of particles measured. To calibrate the Airbeams (n=10 units), two or more Airbeams were placed into an airtight chamber at a time with one PDR 1500 and were then exposed to the exhaust emissions from a gasoline leaf-blower. Both instruments simultaneously recorded PM concentrations in 1-min intervals, which were then used to generate calibration curves for each Airbeam. Results showed a strong correlation between the Airbeam and PDR measurements within a certain range, however, inter-instrument variability and plateauing of the Airbeam measurements when measuring concentrations above ~ 300 μg/m3 were observed. Importantly, the relationship between the Airbeams and the PDR 1500 was linear at concentrations below ~ 150 μg/m3. In addition to lab calibrations, we worked with participants in the field to test how the devices compared in occupational settings. We found that when measured simultaneously, the PDR 1500 recorded higher average concentrations compared to Airbeams in occupational settings. In Addition, we found that participants preferred to wear the low-cost air sensor due to its smaller size and weight making it easier to carry. In conclusion, our findings demonstrate that low-cost sensors have the potential to be reliably used for occupational PM measurements within a certain range, however, importantly, each individual unit requires calibration and testing prior to use for research

quality measurements.

Keyword:air quality sensor, air pollution, sensor technology

1055197
Indoor penetration of PM2.5 during wildfire episodes across California between 2018-2020: effect of physical environment and preventive actions
A. Mousavi, J. Wu; University of California Irvine

Abstract: Recent dramatic and deadly increases in wildfire activities across California have increased attention on caused increase in ambient particulate matter (PM) concentration, and how risk from wildfire might be mitigated. Air quality monitors using low-cost optical PM2.5 sensors can track the emission events such as wildfire smoke locally and regionally and provide supplemental and high-resolution data for risk analysis and prevention strategies. Radical expansion of PurpleAir indoor-outdoor PM sensor network and its application on estimating indoor PM2.5 penetration holds huge potential to examine the change in PM2.5 indoor penetration during wildfire and the effect of multiple physical environment characteristics and preventive actions on reducing it. To this end, we used temporal wildfire perimeter data in January 2018-December 2020 from the California Fire and Resource Assessment Program (FRAP) and National Interagency Fire Center (NIFC) to examine the area burned by wildfires over the entire state of California. Further, Calibrated and quality-controlled PM2.5 concentrations from PurpleAir indoor-outdoor co-located sensor sets (within 500m radial distance) across California were used to calculate indoor PM2.5 penetration based on sensors located in 1km and 1-10km distance zones from the edge of the fire perimeter. Elevation in PM2.5 is calculated based on the baseline scenario of each month at a certain year. Given the lack of systematic data across the state, we used parcel data available from San Diego, Los Angeles from Southern California and San Francisco and Sacramento County from Northern California as House Characteristic dataset from multiple county GIS portals to examine the effect of different physical environment characteristic on changes in indoor PM2.5 penetration. Data tables include the type of the parcel (i.e., house, apartment, or condo), area, number of bedrooms, age of the building and quality class of building in terms of material type and built class. Early results of the study indicated enhanced indoor PM2.5 during the wildfire episodes varied by regions (Northern vs Southern California), fire area, built year of the houses, house area and, more importantly, the quality class of the building. Ongoing research aims to provide quantitative analysis in support of the residents on the effectiveness of the immediate preventive actions as opposed to the built-in physical and environmental factors.

Keyword:air quality sensor, built/indoor environment, geospatial analysis/GIS, Wildfire

1000740
Moderator
E. Kuijpers; TNO

Abstract: Moderator

1000740
Introduction
J. Snawder; Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH)

Abstract: Presentation with introduction to the topic (low cost sensors), information about the overall collaboration between NIOSH, HSE and TNO, goals and ambitions of the collaboration.

1000740
Calibration and validation
E. Cauda; Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH)

Abstract: In laboratory calibration and evaluation of a selection of PM monitors to be used for monitoring occupational exposure situations. Presentation about sensor calibration both theoretical and practical with (first) results from experiments at NIOSH/TNO.

1000740
Contextual information
J. Gorce; Health and Safety Executive (HSE), HSE Science and Research Centre, Harpur Hill, Buxton SK17 9JN, UK

Abstract: Pilot new technologies to automatously capture contextual information (e.g. video, tracking technologies, other sensors (e.g. noise, vibration, heat …) that can be used as proxy for activities, to be ultimately linked to the exposure sensor data. Presentation about localization of workers (beacons, gps etc.) and detection of other contextual information in real-time.

1000740
Application of sensors in the workplace
S. Ruiter; TNO

Abstract: In-field performance of PM sensors for the measurement of respirable dust compared to more conventional, better validated methods during occupational activities where airborne dust presence is expected. First application of low cost sensors in the bakery industry.

CITIZEN SCIENCE AND COMMUNITY-ENGAGED RESEARCH

1094238
Evaluation of Multidisciplinary Community-Triggered Project-Based Approaches to Resolve Complex Environmental Public Health Problems
A. Katner, K. Brisolara; Louisiana State University School of Public Health

Abstract: The aim of this project was to develop and evaluate the outcomes of two

multidisciplinary community-engaged approaches to resolve complex environmental public health problems. Two different projects were designed to enable students to engage communities, identify and assess potential environmental public health problems, and develop adoptable solutions within a real world context. In the first project, a primary and secondary curriculum was designed to engage students in identifying hazards, assessing exposures, estimating and communicating risks, and developing education-, policy-, or technology-driven solutions. A second community-triggered investigation was developed to engage graduate students in characterizing environmental conditions and population exposures for neighborhoods along an inner city highway, and develop viable land use proposals and policies that take into account real-world conditions and community considerations. The different approaches were evaluated through student, teacher and community questionnaires and interviews. Student feedback indicated the importance of hands-on activities, technology-based and career-focused learning, and autonomy in project selection. Teacher feedback indicated a need for guidance in citizen science project implementation; adoption of quiz-based student evaluation tools; alignment with common core standards; and unit independence to facilitate partial curriculum adoption. Community interviews suggest that both projects resulted in outcomes which advanced community interests. Results suggest that a community-focused project-based multidisciplinary learning can impact both communities and students, but it requires teachers to step outside the tradition of compartmentalized learning and standardized testing. The project highlights the importance and benefits of preparing students in inter-professional collaborative approaches and community engagement to solve today's complex systems-dependent environmental public health problems.

Keyword:environmental health, environmental policy, other (specify below), environmental education

1054693

Community Engagement Around Lead Soil Exposure in Philadelphia

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Abstract: As an old, industrial city, Philadelphia is burdened with many sources of lead contamination in the environment. Lead is naturally found in soil, but most lead in surface soil is the result of human activity. In Philadelphia, these sources include leaded gasoline, lead-based paint, lead smelters, and other industries that use lead. Philadelphia had more smelters than any other US city leaving large quantities of legacy lead pollution. Lead is a particularly important exposure risk, considering that there is no safe level of lead exposure, especially for infants and young children. Lead poisoning can cause irreversible IQ loss and lifelong learning and behavioral problems. Public health professionals have focused on lead paint as the primary source of most children's lead exposure. However, lead exposure effects are cumulative and the numerous other sources present in Philadelphia are not well known to residents or health care professionals. To enhance awareness and environmental health literacy around lead, its toxic effects, and strategies to reduce exposure, we engaged the public as citizen scientists to collect and test soil for lead. Our work began with the creation

of an undergraduate course at the University of Pennsylvania designed to teach undergraduates about the epidemiology of lead poisoning, the pathways of exposure, and methods for community outreach. This Academically Based Community Service Course provided undergraduates the opportunity to collaborate with students through the Philadelphia School District to learn about lead in their environment and participate in citizen science by collecting soil samples for lead testing. After a decade of successful collaboration, the citizen science activities were expanded to neighborhoods across Philadelphia through community-based soil collection. Graduate students also engaged in soil collection to answer research questions in neighborhoods with expected legacy lead contamination. To date, over 3,000 soil samples have been collected and mapped on a publicly available website detailing the location and concentration of lead found in each sample. Our goal is to collect and map soil samples from every census tract in Philadelphia through the engagement of the public in citizen science. This presentation will describe the citizen science methods used in soil sample collection and testing throughout the history of the project and the multiple engagement strategies employed including GIS mapping.

Keyword:lead (Pb), community, soil

1054703

A community science mapping activity predicts an increase in particulate matter from the shoreline playa at the Salton Sea of California.

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Abstract: The Salton Sea's shrinking shorelines and the exposed playa are expected to cause future air quality issues for the local communities that live near the shore. This work combined a community science approach with models to forecast future shorelines and PM10 air quality enhancements of exposed playa from the Salton Sea near the community of North Shore, CA. A balloon mapping method was used as a collaborative community science approach to measure the rate of shoreline change from July 2018 through March 2020. The balloon mapping process uses tethered weather balloons with cameras that take photographs over a period of 1 hour as the balloon is walked down the shoreline. The process is collaborative and requires several people to inflate the balloon and pull it along a transect to map the shoreline and make environmental observations along the way. The images were processed into orthophoto rasters and uploaded to ArcGIS desktop and analyzed with the Digital Shoreline Analysis System and compared to earlier satellite imagery. The observed rate of change is much greater during the periods 2017 to 2020 compared to previous years, increasing from an average of 12.53 meters/year between 2002 to 2017 to an average of 38.44 meters/year of shoreline change from 2017 to 2020. The shoreline is projected to be 150 meters from its current position by 2030, followed by another 172 meters by 2041. The forecasted land area was combined with WRF-Chem, a regional transport model, in order to assess potential air quality impacts. The new model predicts that after 20 years, there will be an increase in emissive PM10 dust with the newly exposed playa land surface. The suspended dust is forecasted to transport into surrounding communities and exacerbate PM10 exposure in local communities if no dust control projects are built within the next 5 years. This

community science data is used to advocate with the California's Natural Resources Agency to advocate for better dust control projects.

Keyword:particulate matter (PM), public health, air quality

1091010

Associations between Childhood Manganese Exposure and Behavioral Outcomes in Rural Appalachian Ohio: The Communities Actively Researching Exposure Study

K. Vollet Martin; University of Kentucky

Abstract: Background: Manganese (Mn) is necessary in trace quantities; however, at increased exposure levels the metal poses a risk to neurologic functions. The Communities Actively Researching Exposure Study (CARES) is an established pediatric cohort in eastern Ohio which includes children aged 7-9 living near industrial sources of excess Mn exposure. This study aims to understand the relationship between Mn exposure and behavioral outcomes among CARES participants. Methods: Whole blood, hair, and toenail samples were collected from participating children and analyzed for Mn content. Trained team members administered the Behavioral Assessment System for Children-2 (BASC2), and the Behavior Rating Inventory of Executive Functions (BRIEF). We evaluated linear and nonlinear relationships between Mn biomarkers and behavioral scores. Quartiles of the distribution for each Mn biomarker were represented with categorical variables and the middle quartiles served as the reference group with the following ranges; blood: 8.2 μg/L– 11.2 μg/L; hair 207.2 – 747.0 ng/g; toenails: 0.32 – 1.15 μg/g. We assessed nonlinearity with multiple regression models incorporating covariates such as blood lead, serum cotinine, maternal intelligence quotient, community, parental education, and birth weight. Results: Exposure and outcome data were available for 404 children. We observed a nonlinear relationship between blood Mn measurements and behavioral scores with both low and high blood Mn concentrations associated with worse behaviors. We found significant positive associations among those in the lower quartile (β = 3.25; 95% CI 0.15, 6.36) and upper quartile (β = 3.11; 95% CI 0.03, 6.19) according to blood Mn levels and BRIEF Composite scores. A similar nonlinear relationship was observed between blood Mn concentrations and Global Executive Function scores (lower quartile of blood Mn: (β = 4.05; 95% CI 0.90, 7.21) and upper quartile of blood Mn: (β = 3.56; 95% CI 0.43, 6.69). Conclusions: Low and high concentrations of blood Mn were significantly associated with increased behavioral problems. Future research must work to further elucidate the optimal range of Mn exposure.

Keyword:epidemiology, environmental health, community

1054645

Local Air and Personal Health: Understanding Environmental Exposures in North Brooklyn

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Abstract: Industry, vehicular traffic, construction and other factors have long impacted air quality in Greenpoint and Williamsburg. In recent years, complaints about the air from residents to city agencies have dramatically increased. North Brooklyn Neighbors (NBN), a local environmental justice and community planning organization, partnered with the NYU Grossman School of Medicine – Center for Investigation and Environmental Health (NYU CIEH) to more fully understand potential linkages between local air and personal health. One element of the project was the North Brooklyn Air & Health Survey which was offered online in late 2020 in four languages - English, Spanish, Polish and Chinese - and targeted residents and workers in Greenpoint and Williamsburg. Of the 430 total responders, 345 of completed the survey. Participants were asked about 18 different chronic health diagnoses, as well as nine different acute symptoms. The data revealed that: residents who live near busy streets were five times more likely to be diagnosed with a chronic condition; diagnoses and symptoms differed significantly by sex; proximity to pollution source impacts symptoms; and neighborhood workers typically experience more symptoms than residents. Though limited by a relatively homogenous sample of survey respondents by race/ethnicity, gender, income, and education level this study appears to identify linkages between local air exposures and the health of those who live and work nearby. Moreover, preliminary data from air monitors measuring PM, VOCs and PAHs and placed in pre-designated sites in north Brooklyn, suggest that certain VOCs exceed the EPA annual standards.

Keyword:air pollutants, community, health, symptoms

1054633

The Allies in Reducing Emissions Collaborative's Our Stories Project - using digital storytelling and storymaps to highlight individual and community exposures to air pollution across California

D. Chang, C. Garzon-Galvis; Tracking California (Public Health Institute)

Abstract: Introduction: The exposome can be defined as the measure of all exposures of an individual in a lifetime and how those exposures relate to health. In a series of short 3-4 minute videos, or digital stories, developed by members of the Allies in Reducing Emissions (AIRE) Collaborative , storytellers describe their relationship to air pollution and being exposed at different periods of their own and family members' lives. These digital stories draw on personal narratives to highlight lived experiences and each individual's calling to the community air monitoring work they are doing to improve air quality in environmental justice communities where their stories take place, serving as one tool that others can replicate to gather qualitative data on social and environmental determinants of health. Funding for this digital storytelling project was provided by the Energy Foundation to support the AIRE Collaborative in organizing and working together to advance their goal: to unify community-led efforts to establish community air monitoring networks and projects to inform policy implementation by local air districts, the California Air Resources Board, and the State Legislature. In developing these digital stories, the AIRE Collaborative worked with StoryCenter, a participatory digital media organization based in Berkeley CA, who provided an online workshop to AIRE members and assisted with developing scripts, recording, and video editing. AIRE members also worked with Tracking California, a program of the Public Health Institute that works in collaboration with the California Department of Public Health,

who organized a series of virtual screenings to share these videos with multiple audiences including agency representatives from the California Air Resources Board, the Department of Toxics and Substance Control, the Environmental Health Investigations Branch at the California Department of Public Health, and Tracking California's technical implementation advisory group which includes AIRE members, among others. Presentation Format: In this presentation, participants will have an opportunity to view AIRE digital stories and the StoryMap titled "A Road to Clean Air" developed by Tracking California that houses the digital stories. Beyond viewing the stories, participants will also have an opportunity to hear from Tracking California staff on the process to coordinate the development of the stories and share the digital stories with a broader audience.

Keyword:air pollution, environmental justice, multimedia, multiple stressors, citizen science, community-engaged research, digital storytelling, air quality, impacts of public health policy

1054596

Sustainable Air Quality in Near Highway Affordable Housing: A multiple stakeholder engagement study in Somerville, MA

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Abstract: Siting affordable and mixed-income housing near major roadways in cities places residents at risk of elevated exposures to traffic-related air pollution that can infiltrate indoors. Achieving high indoor air quality, while maintaining thermal comfort and energy efficiency, requires effective engagement of multiple stakeholders ranging from community members to developers to municipal government. We investigated the indoor air quality benefits derived from varying degrees of filtration (MERV 8, 10 & 13) in near-highway, multi-family housing in Somerville, MA, in a project that engages a grassroots organization, an affordable housing corporation, the city housing department, an HVAC-systems designer, and university researchers. One of the goals of the project is to quantify the degree of indoor exposure to particles that derive from outdoor sources. Continuous measurements of ultrafine particles (UFP) and PM2.5 have been completed inside 12 units in 3 buildings with forced mechanical ventilation near major roadways in Somerville. Rooftop monitors near air intake vents were used to compare indoor to outdoor concentrations and thus quantify the degree of infiltration. Simultaneous monitoring of multiple units in a building allowed us to identify similar temporal patterns in multiple units and rooftop data indicating infiltration versus the unique indoor particle generation events associated with a single unit. Carbon dioxide, temperature and relative humidity were also monitored, and participants were surveyed for use of ventilation practices, perceptions of indoor air quality and thermal comfort. Our results indicate that even with MERV 8 filtration in a building within 50 m of an interstate highway (>150,000 veh/day) the indoor concentrations during overnight hours - with no known active indoor sources - ranged from 10-50% of outdoor UFP concentrations. Furthermore, during the day the overwhelming contribution to indoor UFP concentrations in these units was from aerosol generated indoors via cooking. The decay time for a single cooking event varied from 2-3 hours to over 8 hours (depending on ventilation practices) with indoor concentrations exceeding outdoors for 60% of the duration of the events. Our results suggest that promotion

of better ventilation practices, such as via education around the use of cooking range ventilation hoods and exhausts, may be an effective strategy for improving indoor air quality in near-highway multi-family buildings.

Keyword:air quality, particulate matter (PM), ventilation, transportation emissions, indoor air

1054603

Tele-promotora" Program engaging vulnerable small businesses in Latinx Communities

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Abstract: Essential frontline workers in small businesses from the service industry sector have had increased risk of COVID-19 exposure and greater economic impacts due to social distancing and shelter-in-place guidelines. Our novel "tele-promotora" program is a community engaged research framework that allows communications with vulnerable small businesses during COVID-19 as face-to-face interactions have been limited. The program promotes worker safety while responding to small businesses' immediate needs and helping them through the COVID-19 crisis. The novel "tele-promotora" program includes delivering of occupational health information and resources to small businesses, especially beauty salon and auto shops in the Latinx community. Many of the owners and workers in these small businesses have limited education, literacy and computer skills. The program has allowed information and resources to be accessible to them through online distribution including but not limited to website content, social media, webinars, live events, print material and emails. These methods of distribution allow owners and workers to obtain a better understanding of workplace hazards and effective control option. In detail, a website landing page was created to provide these small businesses with information and resources on COVID-19 testing, best practices for small business operations, cleaning and disinfecting, vaccination and what to do if employees tested positive for COVID-19. In order to provide COVID-19 information and resources for beauty salon and auto shops that are easy to access and that keep them informed, a short survey was created. The survey responses helped determine and identify what COVID-19 information and resources they wanted and needed and the best mode of "tele-promotora" delivery. This information was also distributed via social media. Additionally, social media was used to promote the needs assessment survey and re-sharing of partner news updates on COVID-19 support for small businesses. The "tele-promotora" program has confirmed that there is a lack of information to support vulnerable small businesses, especially beauty salons and auto shops during the pandemic and in general.

Keyword:COVID, community, health, other/general

1054556

Citizen science for environmental disasters: toolkits to guide community groups and local health departments

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Abstract: In recent years, the world has experienced numerous disaster events – from hurricanes to a global pandemic. At the same time, there has been tremendous opportunity.

New technologies and communication channels are helping spread ideas, tools, and creativity. Using such tools, frontline communities can engage in disaster citizen science – performing data collection activities to inform preparedness, response, and recovery actions. Disasters are often massive contamination events. Hurricanes such as Sandy or Harvey caused damage to industrial facilities that led to toxic chemical spillage. The Deepwater Horizon oil spill resulted in exposures to oil products across a number of exposure routes. The Fukushima nuclear power plant meltdown raised fears of radiation exposure. And the Flint, MI drinking water disaster exposed an entire population to high levels of lead. Another common thread throughout these disasters however was citizen science. Community members, government officials, and academic researchers, often came together through citizen science to measure extent of contamination and track hazards over time. Given the complexity of research in this area, multisectoral engagement may be essential to conduct research and develop solutions. In terms of stakeholders, our work focused on community groups and health departments in particular. Environmental disasters can strain the relationship between communities and the institutions tasked with managing disaster response. There are numerous examples of disaster events in which community trust in institutions has faltered due to real or perceived missteps in response. Citizen science may present an opportunity for different groups to come together and through this type of community engagement improve both preparedness outcomes and community resilience. To realize the potential benefits of citizen science, we designed two toolkits to provide guidance to community groups and health departments on designing a disaster citizen science project. In this presentation we will discuss the toolkits and the research behind their development. We provide background on the different types of environmental disasters in which citizen science has been used, citizen science methods for exposure assessment, and a five-step approach to designing a disaster citizen science project. Our presentation will also highlight challenges and opportunities for integrating citizen science into community preparedness.

Keyword:emergency response, community, other (specify below), citizen science

1054532

Insights from residents' experiences coping with heat to inform intervention planning in urban heat islands

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Abstract: Heat-related morbidity and mortality are preventable, and cities are developing resilience and adaptation plans for this purpose. Often these plans are designed without the input from the communities, potentially leading to interventions misaligned with the real needs, failing to serve the most vulnerable populations. There is limited work on comprehensive heat exposure assessments that incorporates community-engaged intervention and mitigation planning. During summer 2020 we recruited 22 residents, prioritizing socioeconomic, racial/ethnic and housing heterogeneity. We administered questionnaires to capture information on resident knowledge and behavior related to air conditioning, sleep, hydration habits, transportation habits, health status, heat-coping strategies, heat wave

awareness, heat illness concerns, financial health and perceived social capital. Our approach included learning from and with residents of environmental justice communities and urban heat islands, and engaging with a community advisory team of key stakeholders across multiple sectors, including housing, planning, and climate resilience. All interviews were conducted remotely. Our results suggest economic stressors contribute to resident heat vulnerability. While all participants had some form of air conditioning in their homes, 50% described the living conditions in their homes as hot, and 30% as warm. Employment among our participants was 54%, with 50% of the participants living on a combined income of < $25,000, and 38% reported having to make difficult choices about which bills to pay. Although hydrating is critical during extreme heat events, very few participants reported drinking water. At least half of the participants were staying at home on the hottest weeks, some reporting not having another place to go to cool down. In sharing what we have learned with the C-HEAT advisory team, we identified potential interventions, including financial assistance for AC equipment upgrades and the payment of electricity bills, misting and hydration stations, and cool roofs. Our findings indicate that a more nuanced understanding of residents' experiences is required to develop effective extreme heat interventions. Through engaging with residents of urban heat islands and compiling questionnaires and temperature data findings we are better positioned to suggest interventions that meet the needs of those most impacted.

Keyword:climate resilience, environmental justice, other (specify below), heat adaptation

1054496

The RADAR project. A community-engaged, citizen-science approach to reduce radon exposure in the home and improve environmental health literacy in rural Kentucky

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Abstract: Radon is a naturally occurring environmental carcinogen responsible for approximately 21,000 lung cancer deaths annually in the U.S. Those who smoke or are exposed to tobacco smoke and radon are at an increased risk of lung cancer. Homes are a major source of radon exposure as the gas enters and becomes trapped. Testing for radon is a primarily lung cancer prevention strategy and is necessary to determine exposure risk. In Kentucky, fewer than 1% of homes are tested for radon each year, despite 93% of Kentucky counties have moderate-to-high radon exposure risk potential. Radon on the RADAR (Residents Acting to Detect and Alleviate Radon) is a multidisciplinary, community-engaged citizen science approach to promote home radon testing and mitigation, and increase environmental health literacy (EHL), health information efficacy (HIE), self-efficacy (SE), and confidence to contact (CTC) a radon mitigation professional. Homeowners (N=60) from four rural counties of Kentucky were trained as citizen scientists to test their home for radon for two weeks using a low-cost Airthings® Corentium Home Radon Detector, asked to complete a brief on-line survey assessing EHL, HIE, SE, and CTC at baseline, post home radon testing, and 3-months post-testing, and participate in a post-testing focus group to assess feasibility and ease of testing. Those with high radon (> 4.0 pCi/L) received personalized telephone report back and brief problem solving. Preliminary data on 30

homeowners from two study counties found the mean radon value was 10.09 pCi/L (SD=14.20; range = 0.28 to 60.85), well above the EPA's action level of 4.0 pCi/L. Survey results showed a significant increase from baseline to post-testing that was maintained at f/u for EHL and HIE. There was a significant increase in SE from baseline to f/u. Similarly, there was a significant increase in CTC from baseline to post-testing, and another significant increase from post-testing to f/u. Of the 30 homeowners, nearly one-fourth used tobacco (23%) and one third reported a family history of lung cancer. The citizen science approach has promise as a risk communication strategy in the creation of healthy homes and improving environmental health literacy.

Keyword:radon, environmental health, other (specify below), Citizen Science

1054389

Mixed Models to Assess Auto Repair Shop Worker Exposures to VOCs and Inform a Community Health Worker Intervention

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Abstract: Volatile organic compound (VOC) exposures pose an acute and long-term threat to worker health. Health concerns from inhalation of VOCs range from headaches, nausea, and skin irritation to neurological, reproductive and developmental disease, cancers and other severe implications. Small business auto repair shop workers were recruited by community health workers (CHW) in a predominately Latinx region of Arizona to assess worker exposures and inform an intervention to reduce total VOCs. Personal air samples were collected using real-time photoionizing detectors from twenty-one participants across thirty-six shifts at ten auto repair shops. Participants' and shops' minute-by-minute work activities were recorded throughout the shifts and analyzed to assess factors that contributed to elevated VOC concentrations, such as types of activities performed and ventilation conditions. Results of a linear mixed model which accounts for within and between shop variation showed that all shops exhibited high VOC recordings throughout the day, with all but two shops reaching air concentrations of at least 200,000 ppb and one shop reaching as high as 5,197,456 ppb. The highest overall exposures were recorded during body work under air conditioning and administrative activities with fan ventilation at 51,691 and 16,939 ppb, respectively. Interestingly, these same tasks also demonstrated some of the lowest time-weighted averages at <0.1 ppb when performed with an open garage-style door and 975 ppb when completed outside. Regardless of activities involving chemical use, VOC exposures were driven by ventilation conditions rather than performed activities. Bringing outside air into an inside environment or using VOC-reducing ventilation systems can lower total VOC levels within the entire building. The findings from this study can be used to inform intervention efforts that reduce overall shop exposures to VOCs, thereby minimizing possible detrimental health effects for otherwise at-risk workers.

Keyword:VOCs, health disparities, occupational exposure

1054414

Exposure to Volatile Organic Compounds and Associations with Density and Proximity of Hydraulic Fracturing Wells: Findings from the Exposures in the Peace River Valley (EXPERIVA) study

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Abstract: Background: Northeastern British Columbia (Canada) is an area of intensive hydraulic fracturing for unconventional natural gas exploitation. Hydraulic fracturing operations can release contaminants, such as volatile organic compounds (VOCs), associated with effects such as adverse birth outcomes. We undertook the Exposures in the Peace River Valley study (EXPERIVA) to evaluate residential exposure to contaminants in pregnant women of this region. Objective: The study aimed: 1) to measure VOC concentrations in residential indoor air and tap water from participants and compare values with those measured as part of a large Canadian biomonitoring study; 2) to assess associations between VOC concentrations and density/proximity of hydraulic fracturing wells. Methods: 85 pregnant women participated in this study. We measured 47 VOCs in indoor air and 44 VOCs in tap water samples; measured concentrations were then compared with those reported in the Canadian Health Measure Survey (CHMS). We assessed the association between metrics of well density/proximity and indoor air and tap water VOC concentrations using multiple linear regression for selected VOCs, and correlation analyses for all VOCs Results: 40 and 4 VOCs were detected in >50% of air and tap water samples, respectively. For 11 VOCs, we observed indoor air concentrations >95th percentile of CHMS for 10 to 28% of the study participants. Indoor air levels of chloroform and acetone, and tap water levels of trihalomethanes were positively associated with hydraulic fracturing wells density and proximity metrics. In these models, VOC concentrations were higher for Indigenous participants. In correlation analyses, indoor air concentrations of benzene, toluene, ethylbenzene and xylenes were positively correlated with well density/proximity metrics. Conclusion: Our results suggest that exposure to certain VOCs in pregnant women who participated in the EXPERIVA study is higher than in the general Canadian population, and that concentrations of certain VOCS are associated with hydraulic fracturing well density and proximity metrics. Documenting gestational exposure to environmental chemicals in this region with a particular attention to Indigenous people is paramount for assessing health risks and developing exposure mitigation strategies.

Keyword:air quality, water, environmental justice, hydraulic fracturing

1054312

Project to Understand the Sources and Health Impacts of Local Air Pollution: Building Community-Academic Partnerships in South Central LA

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Abstract: The multiethnic neighborhoods of South Central Los Angeles (SCLA) are exposed to multiple pollution sources compounding with the impact of social and economic stressors. The Project to Understand the Sources and Health Impacts of Local Air Pollution (PUSH) brings together residents of SCLA and academic partners to shape a community-based participatory project rooted in local understanding of the multi-faceted dimensions of air pollution. The SCLA-PUSH coalition implemented a collaborative and creative process to build our community's capacity to understand and assess the state of air quality and its impacts on community health and well-being, using three core strategies: training through the Air Quality Academy, collect data through ground truthing and community science, and through direct engagement with regulatory agencies and policymakers. We trained 70 residents in the science of air pollution, the process of collecting data, and how to engage in policy and regulatory change. Using ground-truthing methods, with mapped coupled gas stations, auto body shops, metal manufacturing facilities, dry cleaners and oil drilling. The results suggest that facilities-of-concern are underestimated as facilities are at times misidentified, misclassified, or missing in official databases. To address this challenge, we conducted a rigorous process that included a detailed review of the industrial classifications, virtual Ground-Truthing, and searches of existing facilities to identify missing or misclassified data. Fiive community monitors were deployed, which showed elevated PM2.5 levels nearly 60% of the time, primarily during winter months. The data from SCLA-PUSH's community air monitoring walks corroborates how community residents may experience harmful exposure to air pollution even when air pollution daily averages may seem healthy. The process of community science of our project coupled with local leadership has resulted in increased funding from regulatory agencies to address air pollution hazards in the community, including the official selection of South Los Angeles for a state-funded air quality improvement plan. Looking forward, this collaborative and residents will work together to produce a roadmap for achieving the transformation of South Central LA's air, primarily through creative technology solutions and innovation rooted in a Just Transition framework, workforce development, and emissions reductions.

Keyword:environmental justice, community, susceptible/vulnerable

1054332

Community-engaged use of low-cost sensors to assess the spatial distribution of PM2.5 concentrations across disadvantaged and non-disadvantaged neighborhoods in southern California

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Abstract: Background: Particulate matter with an aerodynamic dynameter less than 2.5 micrometers (PM2.5) is an air pollutant that is widely associated with adverse health effects. Important PM2.5 emission sources include industry and roadway traffic, which tend to be disproportionately located near low-income communities and communities of color. We applied a community-engaged research approach to assess the distribution of PM2.5

concentrations in the context of socioeconomic factors at the Census tract level within and around the city of Santa Ana, CA. Methods: Approximately 5,000 minutes of PM2.5 air sampling was conducted by volunteers from the Madison Park Neighborhood Association and surrounding community using 45 low-cost air pollution sensors. Air sampling was paired with real-time GPS tracking devices and took place over an approximately 285 km2 area within and around Santa Ana during morning, afternoon, and evening periods on four separate days from February to May, 2020, in order to characterize the spatial, diurnal and seasonal variation in PM2.5 levels. Using ArcGIS, a continuous smoothed map of PM2.5 concentrations was mapped across the study region. American Community Survey data was used to examine PM2.5 across Census tracts based on social and economic factors. Results: PM2.5 concentrations varied by proximity to freeways and by socioeconomic factors. Air sampling that took place within the Santa Ana city boundary had 17% higher mean PM2.5 concentrations and 257% higher max PM2.5 concentrations compared to neighboring areas. The magnitude of this difference was greatest when socioeconomic factors were considered. On average, Census tracts with median household income < $50,000 tended to have higher PM2.5 concentrations than high-income Census tracts. The highest PM2.5 concentrations were observed in the evening (4-7PM), compared to morning or afternoon. Discussion: This study demonstrates the utility of low-cost air pollution sensors for the use of community-engaged air sampling and awareness projects. What is more, results from this study underscore the existence of environmental health inequities that persist in urban areas today, thus informing environmental justice-related initiatives focused on community outreach and the formulation of community-driven recommendations for policy makers.

Keyword:air pollutants, environmental justice, community

1054289

Investigation of Firefighter Exposures to Polychlorinated Biphenyls (PCBs) Using Silicone Dog- Tags

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Abstract: Structural firefighters provide critical services to communities around the world despite the occupational hazards that they face. One such hazard, is exposure to a suite of chemicals released during a fire. In particular, polychlorinated biphenyls (PCBs) are a concerning class of chemicals, which persist in older building materials and electrical equipment (e.g. transformers). PCBs are recognized as endocrine disruptors, carcinogens, and developmental toxicants. Furthermore, some studies have shown structural firefighters to have elevated levels of PCBs in their serum. In this study, silicone passive samplers similar to military dog-tags worn around the neck were used to measure the bioavailable fraction of PCBs firefighters were exposed to while on- and off-duty. The dog-tags were worn by firefighters for a total of 30 24- hour shifts (n=57). These firefighters were from two different stations in the Kansas City metropolitan area, one of which had fewer than two calls to respond to per month on average (low call volume), and one that had more than 12 calls per month on average (high call volume). Additional questionnaire data was collected on number

of fire attacks an individual participated in, demographics, and lifestyle information that might influence chemical exposures. The dog-tags were extracted using solvent and underwent solid phase extraction prior to instrumental analysis. Gas chromatography - mass spectrometry (GC-MS) was used to analyze the extracts for 43 PCB congeners. PCBs were detected in sample extracts from 16 different firefighters, 12 of which were from the high call volume station. Out of 12 detected congeners, PCB 153 was the most frequently detected. Statistical analyses will be used to assess whether PCB concentrations were higher at the high versus low call volume department and while on- compared to off-duty. Finally, we will explore correlation between questionnaire data such as number of fire attacks, and firefighters' individual PCB exposures. Although firefighters may be exposed to increased levels of PCBs in house fires, few studies have monitored these exposures. There are even fewer studies that measure dermal exposure, even though PCBs are known to be absorbed through and distributed to the skin. Given the hazards posed by PCBs, it is critical that we better understanding individual firefighters' exposures to PCBs while on- and off-duty.

Keyword:emergency response, occupational exposure, other (specify below), PCBs

1054344

Understanding the urban smellscape: Developing a screening method for odour source identification using citizen science and back trajectory modelling

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Abstract: Odour exposure is associated with adverse and inequitable impacts on quality of life, yet studying odours and identifying their sources remains complex. Variability in individual sensitivity and perception, mixtures of odorous contaminants, and the role of meteorology and chemistry can contribute to these challenges. Here, we develop a screening methodology to assess the extent of odour impacts from specific sources using citizen science and back trajectory modelling. This methodology was applied to case studies of sources such as cannabis cultivation facilities (CCFs) and waste water treatment plants in Metro Vancouver, Canada. Community participation occurred through a web application through which users could submit odour reports. The times and locations of relevant reports were used as receptors for back trajectory modelling, performed with the Hybrid Single Particle Lagrangian Integrated Trajectory Model and meteorological data from the Weather Research and Forecasting and High Resolution Rapid Refresh models. Meteorological ensembles consisting of trajectories with deviations in initial meteorology were performed at starting heights of 10m and 25m. Metrics were developed using the back trajectories to evaluate which sources were likely to have impacted a report, and which sources were contributing to the most reports. Trajectories were weighted based on their proximity to the source. In a 20-week period, approximately 23% and 10% of the 261 reports received were associated with odours of cannabis and sewage, respectively. In preliminary analysis of reports received in the first 10 weeks, the maximum likelihood for a report to have been impacted by a CCF was 30% for our most conservative metric. Social participation is a low-cost and widely applicable method for odour evaluation when compared with instrumental methods, which often are unable to detect odours that the human nose can. The proliferation of smartphone

use enables more individuals to provide accurate location data for reports, and there are few limitations on the location or time of data collection. Information on odour sources can empower communities, and can be used by policy-makers to support the mitigation of negative environmental, wellbeing and equity impacts associated with odourous emissions. Due to the low cost of data collection, this methodology is widely applicable for odour source identification, and can be used as a screening method for further investigation of odour sources.

Keyword:community, VOCs, other (specify below), odour

1054357

Air sensor networks in lieu of a regulatory air monitoring network: the case study of Ukraine

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Abstract: Like other former Soviet nations, Ukraine inherited air monitoring equipment which is comparable to the devices used in the US over a half century ago. Resulting data are poor quality and cannot properly assess compliance with air quality standards or provide real-time public information. Ukraine cannot afford to establish a modern air quality network to measure exposures in large urban and industrial centers. However, various NGOs and municipalities have installed networks of sensors for particulate matter (PM) and other pollutants across the country. These sensors are not on a par with US Federal Reference Methods and are not part of a formal network with quality control/quality assurance programs. Nonetheless, many of them are well situated in populated areas and upwind/downwind of major metallurgic sources. We have downloaded sensor data from select industrial communities and meteorology from nearby airports. We applied routine data validation methods to characterize the data quality and assess its usefulness to describe population exposures and potential health risks. Sensor data were paired with local hourly wind direction and wind speed to generate pollution roses and other graphics as a ground-truthing of data trends. For example, we show that PM reported at monitors around the massive integrated steel plant in Kryviy Rih is distinctly higher during periods when the monitors are downwind of the facility. Long-term trends also show that sensors closer to the plant have overall higher readings than those further away and at rural comparison sites. One of the near-fenceline sensors reports an annual PM2.5 average of 21 ug/m3 and maximum 24-hour period of 218 ug/m3, as compared with respective WHO Air Quality Guidelines of 10 and 25 ug/m3. The data time-lines exhibit odd jumps, which bring into doubt the absolute concentration (calibration) of PM data. The sensor data are useful, but are not a replacement for a quality-assured regulatory network. European and other international partners should support Ukraine in establishing a rudimentary PM network. These reliable sites should continue to then be supplemented with the various sensors, which likely will improve in quality over time.

Keyword:air quality sensor, particulate matter (PM), environmental justice

1054261

Assessing Indoor Exposure of Nitrogen Oxides in Children in Hispanic Households

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Abstract: Increasing nitrogen oxides levels inside the households adds to concerns regarding indoor air quality and the health effects. Few studies have investigated the indoor air quality and concentrations of harmful air pollutants in relation to Hispanic children. The main objectives were to assess indoor air quality and the factors affecting indoor air quality among Hispanic children in the greater Philadelphia region. In this study, we investigated the indoor nitrogen oxides concentrations in 24 households with Hispanic children in the greater Philadelphia area from November 2020 to March 2021. A member of each studied household completed a survey containing information on household location, amenities, and daily schedules. Ogawa passive samplers were used to measure nitrogen oxides, and the sampling was conducted from each household for five days. Overall nitrogen oxides concentrations were greater in households with gas stoves (33.45 ± 29.51 ppb of NO2 and 16.92 ± 21.93 ppb of NO) than in the households with electric stoves (27.04 ± 41.78 ppb of NO2 and 5.82 ± 8.45 ppb of NO). The nitrogen oxides concentrations were higher in the households in close proximity to highways than households that are not. The results of this study will show the state of indoor air quality among children in minority communities and potential health consequences.

Keyword:air quality, exposure factors, built/indoor environment

1053548

Personal care product use among diverse women in California: Taking Stock Study

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Abstract: Women of color, particularly Black women, have higher exposures to certain consumer product chemicals, including some that are hormonally-active. Differences in product use, partially driven by socio-cultural factors, may contribute to exposure inequities. However, the lack of data on product use by women of color makes it difficult to connect product use patterns with exposure and health disparities. We surveyed 357 California women (aged 18-34 years) about their use of cosmetics, hair, feminine care, and leave-on and rinse-off personal care products. We compared product use, frequency of use, and use of scented products among Black, Hispanic/Latinx, Asian, and White women. We also asked why women choose products and where they seek additional information about products. Women reported using, on average, 8 of the 54 product types daily, and some up to 30 products daily. Use of specific products was correlated so aggregate chemical exposures are a concern. There were significant differences in use by race/ethnicity for about half of the product types. Hispanic/Latinx and Asian women reported greater use of cosmetics than Black and White women, Black women reported significantly higher number of hair products and slightly more menstrual/intimate products. Scented product use was common; with 70% of women reported at least half products asked about as scented. Women reported choosing

products because of price and effectiveness, and less so brand name, and relying on family and friends for product information. We found significant differences in product use and frequency of use across races/ethnicities. These data are important for developing strategies to limit exposure to harmful consumer product chemicals in order to address exposure and health inequities. Results suggest that behavior change interventions focused on alternative products of similar price and effectiveness and supported by friends and family could be effective. Recommendations to alter personal behaviors related to product use should be complemented by approaches that tackle policies and external and internal socio-cultural pressures that perpetuate disparities.

Keyword:consumer and personal care products, behavior, environmental justice

1053187

Community-engaged research on drinking water disinfection byproduct exposure in Martin County, Kentucky

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Abstract: The Martin County Kentucky Water District has had a history of quarterly violations of the Safe Drinking Water Act for disinfection byproducts (DBPs), leaving local citizens with a number of questions about DBP exposure and potential health effects. Working with citizen scientists from the community and based on community input, the study team designed and implemented a population-based study involving visits to 97 households in Martin County, Kentucky to collect water samples for analysis of DBPs over the course of one calendar year (2018-2019). Drinking water analyses indicated that DBPs frequently exceeded the U.S.EPA MCLs for total trihalomethane (THMs) and haloacetic acids (HAA5) in individual samples, although drinking water utilities are regulated based on running annual averages. The presence of of several individual compounds, including brominated DBPs, with MCL goals of zero was also observed. Overall, we observed no obvious spatial pattern to the concentrations of TTHMs; however, HAA5 concentrations tended to increase in some areas more distant from the drinking water treatment plant. There was a strong seasonal pattern for both classes of DBPs, with concentrations of DBPs frequently exceeding MCLs in the summer and early autumn in contrast to lower winter and spring concentrations. The DBP concentrations could be reasonably well predicted based on water temperature, conductivity and free chlorine content. Of the other measured variables, the TTHM concentrations were strongly correlated with conductivity, while HAA5 concentrations were correlated with temperature and distance from the treatment plant. Seasonal changes in discharge of the Tug Fork River (the source water which is pumped into the Crum drinking water reservoir), may explain changes in the conductivity of the drinking water. It is possible that conductivity is a correlate of total organic carbon (TOC) content in the source water rather than a driver of DBP formation; however, this study did not measure source water chemistry and TOC from the source water would have been largely removed during the treatment process in contrast to dissolved ions. The health consequences of seasonal fluctuations in exposure as well as the presence of brominated DBPs, which tend to have higher toxicity, merit further study.

Keyword:water, community, other (specify below), Disinfection byproducts

1052606

Influences of Variability of Dose Metrics on the Personal Exposure to Traffic-related Air Pollutants in Children with Asthma

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Abstract: Background: Central-site estimates of exposure to traffic-related air pollutants (TRAP) are affected by errors that tend to distort health risk estimates. To better assess individual-level exposure, we designed four dose metrics and compared the variability of estimated doses among children with asthma living in low-income, minority neighborhoods. Methods: Thirty-five children with mild-to-moderate asthma residing in communities adjacent to the Port of Newark/Elizabeth, NJ were recruited to participate for up to 30 consecutive days in a community-engaged study. Four dose metrics for TRAP were calculated, using black carbon (BC) as a surrogate. Model A used daily BC measurement from New Jersey Air Monitoring Station and the median age group-, sex-, body weight-specific inhalation rate from the US. EPA Exposure Handbook. Model B used personal monitored measurement and the same inhalation rate. Model C and D used central-site and personal-monitored BC concentration and dynamic inhalation rate calculated from the self-reported time-activity questionnaire. We examined differences in estimated inhaled dose by time and location and compared the between- and within-subject variation. Results: We found a higher median dose from metrics using central-site estimates compared to those using personal measurements. The median inhaled dose tended to be higher during daytime compared to the nighttime in all models except Model A. The median inhaled doses were lower indoors relative to other environments using all dose models. We observed larger within-subject variance using metrics that accounted for the dynamics of personal behaviors (Model C and Model D), relative to metrics that did not (Model A and Model B). The metric that relied on personal monitored BC had larger between-subject variation compared to the metric that used central-site estimates. Dose metrics that used measurements from central-site monitors appeared to overestimate the dose, while underestimating spatial and temporal variation of TRAP, relative to measurements from personal monitors, which may be considered reference standard measurements. Conclusions: Our findings confirmed that relying on central-site measurements in the setting of our studies may overestimate potential inhaled dose while failing to characterize the spatiotemporal variation of the individual-level inhaled dose of TRAP, relative to metrics that accounted for the dynamics of TRAP pollution and personal behavior patterns.

Keyword:air pollutants, asthma, health disparities

1049017

Engaging multiple communities to define the exposome

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Abstract: Exposure scientists defined the exposome concept to encompass all lifetime exposures including toxicants, diet, lifestyle choices, and socioeconomic factors. However, initial applications of the exposome have been less apt at measuring social determinants of health and have instead focused primarily on conventional environmental exposures and lifestyle choices (individual health and behaviors) that do not reflect the complex lived experience of many communities. To learn the community's definition of their exposome, the HERCULES Exposome Research Center and its Stakeholder Advisory Board co-developed the Shaheed DuBois Exposome Roadshow Workshop. The two-day Workshop uses a popular education approach with Group Concept Mapping to bring Atlanta-area communities together around their exposome-related concerns. Group Concept Mapping provides a systematic method to collect and visualize community members' knowledge in order to create a shared understanding and organize for action. Concept maps are created from participants' brainstorming, sorting, and rating of their responses to the prompt: "What in your environment is affecting your health and your community's health?" A total of 118 community members from four distinct communities across the metro-Atlanta region participated in four separate workshops. On average, each community's maps included seven concepts (or themes) that defined their exposome. Concept names ranged from "Environmental" and "Result of Pollution" to "Public Safety", "Government Issues", "Healthy Eating", and "Physical Infrastructure". The resulting four concept maps offer a community definition of the exposome and visualize the interconnections between themes. While the maps differed in their individual results, five major themes arose across all four communities: conventional environmental concerns, built environment and structural determinants of health, family and community, crime, and individual health and behaviors. These communities' exposome definitions demonstrate the importance of sociological influences on individual and community health. To truly capture the totality of lifetime exposures and improve human health, interdisciplinary collaborations are needed and should incorporate the perspectives of different communities into exposome research.

Keyword:community, environmental health, other (specify below), exposome

1044463

Evaluating couch polyurethane foam for a potential passive sampler of semivolatile organic compounds

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Abstract: Background/Objective: Polyurethane foam (PUF), a proven sampling medium for measuring air concentrations of organic compounds, is widely used in upholstered home furniture. We evaluated the potential utility of couch PUF as a passive sampler and as a

reservoir for non-flame retardant semivolatile organic compounds (SVOCs). Methods: We collected PUF samples from 13 California home couches, measured concentrations (CPUF) of 64 SVOCs at three different depths (i.e., top, top-middle, and middle from couch surfaces facing outward), and examined concentration changes with depth. To calculate the PUF-air partition coefficient (KPUF-air = CPUF/Cair = CPUF × Kdust-air/Cdust), we used the calculated dust-air partition coefficient (Kdust-air) with the octanol-air partition coefficient (Koa) and dust concentrations (Cdust) simultaneously collected and measured. We used KPUF-air to compute fugacity capacity of PUF and chemical mass distribution among various indoor compartments and PUF. Results: Among 29 detected compounds, 11 compounds were detected in more than 50% of the samples at all depths. Among the 11 compounds, concentrations of phenanthrene, 2-benzylideneoctanal, galaxolide, tonalide, and homosalate decreased with depth. Among the studied SVOCs, more than 20% of the total mass was distributed to couch PUF for phenol and compounds in skin-applied products (i.e., 2-benzylideoneoctanal, galaxolide, and homosalate). Conclusions: Our results showed that couch PUF can absorb many SVOCs and may be an important reservoir for some SVOCs. However, it may not be an effective passive sampling medium for those that have relatively high Koa values. Direct dermal contact with couch seats may be an important exposure route for skin-applied compounds.

Keyword:consumer and personal care products, sampling methods, SVOCs

1043071

Factors Affecting Lead Dust in Construction Workers' Homes in the Greater Boston Area

D. Ceballos[1], R. Herrick[2], J. Spengler[2]; [1]Boston University School of Public Health, [2]Harvard Chan

Abstract: Lead is a known reproductive, developmental, and neurological toxicant. Workers that are exposed to lead at work can inadvertently transport lead home from work, known as "take-home exposure." This presentation will 1) explain the persistence of lead take-home exposures through history and through an equity lens, 2) describe the Harvard Take Home Study and present results of lead dust in the homes of lead-exposed construction workers compared to other occupations. During a visit to worker residences (30 visits in 2018-2019), a worker questionnaire was administered, and observations and a dust vacuumed sample of the home were collected. Factors predicting lead in home dust were explored by a bivariate analysis and a multivariable regression model. We found lead in homes' dust in the range of 20–8,310ppm. Homes of construction workers generally had higher and more variable lead dust concentrations (mean 775, max 8,300ppm) than autobody and janitor worker homes combined (mean 296, max 579ppm). Five of the construction workers' home lead dust concentrations exceeded US guidelines for yard soil in children's play areas of 400ppm, and were similar to other studies of homes near lead smelters, superfund sites, or in the Boston area in the early 1990s, pointing to disparities relating to work. Results from the multivariable regression model suggest that lead dust in homes of workers was associated with sociodemographic-, home-, and work-related factors, and pointed to overlapping vulnerabilities; however, a larger sample size is needed to verify findings. Results provide

evidence that work-related factors are important to consider when assessing home exposures, and that take-home exposures for workers in lead high-risk jobs such as construction may be an important source of exposure in the home prime for public health intervention at work, home, and community levels. Recognizing take-home exposures as a public health hazard and studying them through an ecosocial view is essential for effective prevention. Including the role of work in community health will increase the comprehensiveness of prevention efforts for contaminants such as lead that contribute to environmental disparities.

Keyword:lead (Pb), built/indoor environment, occupational exposure

1042262

Survey of Airborne Organic Compounds in Residential Communities Near a Natural Gas Compressor Station: Response to Community Concern

E. Lin[1], K. Vollet Martin[2], K. Vollet Martin[2], E. Lin[1], T. Hilbert[3], K. Godri Pollitt[1], E. Haynes[2]; [1]Yale University, [2]University of Kentucky, [3]University of Cincinnati

Abstract: Introduction: Natural gas compressor stations are located throughout the country and are used to maintain gas flow and ensure continuous distribution through the pipeline network. Compressor stations emit many air contaminants including volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). While the serious health effects associated with the inhalation of elevated pollutant levels are clear, the relationship between proximity to natural gas compressor stations and residential health effects is not well understood. Community members living near a natural gas compressor station in Eastern Ohio expressed concerns regarding their air quality; therefore, the objective of this study was to assess exposure to airborne pollutants in residential air near the compressor station. Methods: Our team conducted a 24-hour air sampling campaign to assess outdoor and indoor air contaminant levels at 4 homes near the Williams Salem Compressor Station in Jefferson County, Ohio. Air quality was assessed using two techniques: 1) summa canisters to quantify VOC concentrations and 2) passive air samplers to evaluate a broader panel of VOCs and SVOCs. Results: Among the three homes situated < 2 km from the compressor station, indoor benzene levels were 2-17 times greater than the Ohio Environmental Protection Agency (EPA) indoor standard due to vapor intrusion. Multiple other VOCs, including ethylbenzene, 1,2,4-trimethylbenzene, 1,2 dichloroethane, 1,3 butadiene, chloroform, and naphthalene also exceeded state standards for indoor concentrations. Several SVOCs were detected inside and outside participants' homes, including benzene and naphthalene derivatives. Conclusion: Our results validate the community members' concerns and necessitate a more comprehensive epidemiological investigation into the exposures associated with natural gas compressor stations and methods to mitigate elevated exposures.

Keyword:SVOCs, VOCs, other (specify below), indoor air quality, passive samplers, natural gas compressor stations

1038802

Pilot Testing Two Take-Home Exposure Prevention Educational Sessions with Construction Workers and their Families

G. Tore[1], J. Noguchi[1], J. Green[2], J. Peters[1], K. Carey[2], J. Levy[1], D. Ceballos[1]; [1]Boston University School of Public Health, [2]Boston University Wheelock College of Education and Human Development

Abstract:"Take-home exposures" occur when workers accidentally bring home contaminants they are exposed to at work. In the construction industry, regular job responsibilities may expose workers to lead and other heavy metals, which extend to their household members via the take-home pathway. Current workplace standards for construction regulate occupational exposures to lead, but the burden to prevent take-home exposure falls on individual workers. It is crucial that construction workers are aware of the take-home pathway and learn about exposure reduction strategies to prevent their household members from being inadvertently exposed. This work is part of the RECLEAN Pilot Study, which aims to reduce lead in the homes of construction workers by applying educational and environmental interventions. In the first phase of the study, we developed and evaluated a suite of educational materials to train construction workers and their families on best practices for preventing or reducing exposure to take-home lead. Each of the two sessions is tailored to a specific audience with one focusing on construction workers and their peers and the other on the worker's family or household members. The sessions were originally developed to take place in person but given the COVID-19 pandemic we have adapted them to be offered online as well. Similar to traditional occupational health and safety trainings, the construction worker sessions present workers with best practices to prevent take-home lead and open discussion for how such practices may fit into their own routine when leaving work. Alternatively, the in-home family session is designed to include the whole family in a process derived from motivational interviewing. The materials for both sessions include an introduction, a take-home behavior scoring sheet, a take-home behavior wheel, and an action plan. Facilitators and participants discuss strategies to prevent take-home lead, identify barriers participants (and their coworkers or families) experience when trying to change their behaviors, and ultimately prioritize a prevention goal. The materials for both educational sessions were developed based on current literature on take-home lead and behavioral theories and in partnership with lead and construction experts from multiple organizations. Using feedback from participants, project stakeholders, and session facilitators, we evaluate the feasibility and efficacy of these educational interventions.

Keyword:lead (Pb), behavior, children

1000748

Research to Action Approaches with Environmental Justice Community Near Urban Oil Drilling

J. Johnston; University of Southern California

Abstract: This presentation will share the development of a community-driven methodology community-driven methodology to assess environment and health among community residents and how the research was leveraged to support policy action at the local and state level.

1000748

Moderator
B. Shamasunder; Occidental College

Abstract: Bhavna will moderate the symposium and put it in the context of environmental injustice and intersectionality.

1000748
Community Organizing, Community Health Promoters and Environmental Justice Research near Oil Drilling Sites
S. Navarro; LA Grit Media

Abstract: From the community perspective, this presentation will describe the role of community health workers, infographic and organizing to change policy as well as engage researchers to address local concerns.

1000748
Moderator
M. Chan; Harvard T.H. Chan School of Public Health

Abstract: Marissa Chan, a graduate student at Harvard T.H. Chan School of Public Health, will moderate this symposium.

1000748
Environmental Justice Dimension of Urban Oil and Gas Drilling in Los Angeles County
M. Chan; Harvard T.H. Chan School of Public Health

Abstract: Social and environmental stressors are combined in low income communities and communities of color. The resulting cumulative burden contributes to disparities in well-documented health inequalities reported among environmental justice communities. We examined the location of active oil and gas production on-shore wells in Los Angeles County and find community facing more environmental hazards are also more likely to be near an active oil operations. The work can inform the reexamination of policies and frameworks which may reduce exposure from oil and gas development on an individual or state-wide level.

1000748
Using a community monitoring network to assess methane and non-methane hydrocarbons levels
K. Okorn; University of Colorado Boulder

Abstract: Over the past decade, low-cost sensors have been proven valuable to assess air quality on highly localized scales. Here we leverage innovative sensors to characterizes gaseous pollutants in a complex urban environment and evaluate differences in air quality in three different Los Angeles neighborhoods where oil and gas activity is present. The results demonstrate that methane emissions are higher within a 500 m radius of three urban oil and gas facilities, as well as near a natural gas distribution pipeline.

992334

Factors Affecting Lead Dust in Construction Workers' Homes in the Greater Boston Area

D. Ceballos; Boston University School of Public Health

Abstract: Lead is a known reproductive, developmental, and neurological toxicant. Workers that are exposed to lead at work can inadvertently transport lead home from work, known as "take-home exposure." This presentation will 1) explain the persistence of lead take-home exposures through an equity lens, 2) describe the Harvard Take Home Study (during 2018-2019), and 3) present results of lead dust in the homes of lead-exposed construction workers, as well as key sociodemographic-, home-, and work-related factors pointing to overlapping vulnerabilities.

992334

Pilot Testing Two Tailored Educational Interventions to Prevent Take-Home Lead Exposure in the Homes of Construction Workers and their Families

G. Tore; Boston University School of Public Health

Abstract:"Take-home exposures" occur when workers accidentally bring home chemicals they are exposed to at work, such as lead or pesticides. In the construction industry, regular job responsibilities may expose workers to lead and other heavy metals, which can extend to their household members via the take-home pathway. This presentation will describe the first phase of the RECLEAN Pilot Study (during 2020-2021) that aims to prevent take-home exposures to lead in the homes of construction workers. To accomplish this goal, two distinct educational interventions tailored toward construction workers and their families have been developed, reviewed by community partners and pilot tested with participants.

992334

Evaluating Mitigation Strategies to Protect Hospital Workers and Reduce SARS-CoV-2 Transmission to Families (EMPOWRS Pilot Study)

J. Noguchi; Boston University School of Public Health

Abstract: Take-home exposures vary from chemicals to infectious diseases, including COVID-19. However, the efficacy of the measures taken by hospital workers in their homes to prevent household exposure remains unknown, as do the most effective take-home mitigation strategies. This presentation will describe the EMPOWRS Pilot Study conducted at Boston University School of Public Health and demonstrate a brief interactive online module on how hospital workers can prevent transmission of COVID-19 from work to home.

992334

Para-occupational determinants of cholinesterase inhibition in children and adolescents

J. Suarez; University of California San Diego

Abstract: Acetylcholinesterase activity is a physiological biomarker of exposure to cholinesterase inhibitor pesticides such as organophosphates and carbamates. Through analyses from childhood to adolescence among 623 participants living in agricultural communities in Ecuador (1156 observations from 3 examinations: 2008-2016 in the ESPINA study), this presentation describes analyses of 2 para-occupational determinants of acetylcholinesterase activity: A) Cohabitation with floricultural workers (including various

take-home pathways) and B) Residential proximity to floricultural crops.

997005
Negotiating mountains, miles and more: A community/academic partnership addresses air quality in rural Appalachia
B. May; University of Kentucky

Abstract: Rural Appalachians experience marked disparities in chronic respiratory diseases. A community based participatory research project based in two eastern Kentucky counties trained local lay health workers in interviewing and collection of spirometry. In addition, monitoring for air quality was conducted a subset of participant homes. Findings led to an intervention for adults with asthma which included home visiting by RNs trained in asthma self-management, healthy homes education and home inspections by local construction workers trained in the principles of healthy homes.

997005
Mountains, miles and more: A community/academic partnership addresses air quality on school buses in rural Appalachia
C. Wilmhoff; Buckhorn High School

Abstract: This community-academic partnership deployed Appalachian high school students as citizen scientists to sample air quality on school buses purchased before and after DERA. Air quality levels on the pre- and post-DERA buses were compared to student absences from those buses to identify potential relationships. The research team members will discuss the benefits and challenges of engaging high school students to conduct environmental health research.

997005
Mountains, miles and more: A community/academic partnership addresses drinking water quality in rural Appalachian
N. McCoy; Martin County Concerned Citizens

Abstract: Community concerns about drinking water quality led to this partnership-driven study to test tap water in Martin County, KY. Community and academic research team leaders will discuss the process of designing and implementing sampling processes in this rural KY community, which has longstanding trust issues arising in part from an environmental disaster that occurred there in 2000.

997005
Mountains, miles and more: A community/academic partnership addresses air quality on school buses in rural Appalachia
A. Hoover; University of Kentucky

Abstract: This community/academic partnership deployed Appalachian high school students as citizen scientists to sample air quality on school buses purchased before and after DERA. Air quality levels on the pre- and post-DERA buses were compared to student absences from those buses to identify potential relationships. The research team members will discuss the

benefits and challenges of engaging high school students to conduct environmental health research.

997005
Mountains, miles and more: A community/academic partnership addresses drinking water quality in rural Appalachia
J. Unrine; University of Kentucky

Abstract: Community concerns about drinking water quality led to this partnership-driven study to test tap water in Martin County, KY. Community and academic research team leaders will discuss the process of designing and implementing sampling processes in this rural KY community, which has longstanding trust issues arising in part from an environmental disaster that occurred there in 2000.

CLIMATE CHANGE

1054420
Examining the light-absorbing properties of water-soluble and insoluble organic aerosols at a regional background site in India
S. Yadav[1], S. Dubey[1], T. Kapoor[2], S. Duhan[3], J. Laura[3], C. Venkataraman[1], H. Phuleria[1]; [1]Indian Institute of Technology, [2]Indian Institute of Technolgy, [3]Maharshi Dayanand University

Abstract: In recent years atmospheric brown carbon (BrC) is established as a significant contributor to light absorption and positive climate forcing. Thus, it is important to understand temporal and spatial variability of BrC as its sources are complex. The aim of study is to determine optical properties of BrC and its seasonal dependence by measuring light absorption spectra of water and methanol extracted organic carbon. Particulate matter (PM2.5) was collected over regionally background site, Rohtak in India every alternate day during Jan-Dec 2019. The light absorption spectra of water and methanol extractable organic carbon were measured along with organic (OC) and elemental carbon (EC). Absorption coefficient at wavelength 365 nm (babs365 w), (babs365 m) and mass absorption efficiency (MAC365 w), (MAC365 m) for water and methanol soluble OC, respectively were investigated to study BrC variability. The babs365w and babs365m displayed distinctive seasonal variations with highest absorption during the winter (6.6 ± 1.6 Mm-1) and low during summer (2.8 ± 0.3 Mm-1) and monsoon (2.8 ± 0.7 Mm-1) months. Similarly, babs365m was highest during winter (11.5± 10.6 Mm-1), followed by the summer (3.6± 1.6 Mm-1), and monsoon (1.3± 0.3Mm-1), which implies that water-insoluble fraction of OC is also highly absorbing. The corresponding OC, EC and PM2.5 followed similar trend with winter (11.3±8.5 µg m-3, 6.5±4.7 µg m-3, 115.8±103.0 µg m-3), summer (6.7±3.0 µgm-3, 3.2±1.2 µgm-3, 78.0±21.3 µgm-3) and monsoon (3.5±0.3 µgm-3, 1.8±1.6 µgm-3, 52.1±43.0 µgm-3) concentrations, respectively. Average MAC365w and MAC365m (normalized with OC) were 0.7± 0.4 and 0.9± 0.1 m2g-1 (winter), 0.5± 0.2 and 0.5± 0.3 m2 g-1 (summer) and 0.7± 0.01 and 0.3± 0.1 m2 g-1 (monsoon), respectively. The babs365w and babs365m showed significant correlation with all the OC fractions with highest being with OC1 (r^2=0.7 and 0.9, $p<0.05$, respectively) suggesting presence of significant but variable fraction of

chromophores. The higher correlation of babs365m with OC indicates that water insoluble components contribute significantly to the aerosol absorptive properties. The high correlation of babs365m with EC1 (r2= 0.9) indicates that water insoluble BrC components and EC1 have similar sources. Our first results provide distinct seasonal variation in aerosol optical properties and both water soluble and insoluble OC show strong evidence of BrC in collected aerosols. Further analysis and examination is underway.

Keyword:aerosol, air pollution, climate change

COVID-19

1054405

How important is airborne transmission for the spread of COVID-19? A systematic review

S. Vardoulakis[1], D. Espinoza Oyarce[1], G. Nichols[2], G. Lo Iacono[3], P. Kumar[3], P. Lauriola[4], J. Menezes[5], C. Huang[6], M. Hashizume[7], H. Kim[8], G. Leonardi[2]; [1]Australian National University, [2]Public Health England, [3]University of Surrey, [4]International Society Doctors for the Environment, [5]FIOCRUZ, [6]Sun Yat-sen University, [7]University of Tokyo, [8]Seoul National University

Abstract: There is increasing recognition that airborne transmission via virus-laden particles is an important pathway for the spread of COVID-19. At initial stages of the pandemic, airborne transmission was thought to be limited to aerosol generating procedures during clinical care of COVID-19 patients, while direct contact and droplet spread was thought to dominate community transmission. However, epidemiological, modelling and outbreak studies have indicated that substantial transmission of COVID-19 has occured via the airborne route, mainly in indoor settings. We carried out a systematic review of the scientific literature on airborne transmission of COVID-19, including experimental, epidemiological, and mathematical modelling studies in any human population published before December 2020. We searched PubMed, MEDLINE, Scopus, Cochrane Library, and relevant government agency databases. No restrictions were imposed on health status, age or setting (outdoor, indoor, residential, occupational). We extracted information regarding environmental conditions and activity patterns. The primary outcomes of the review were confirmed COVID-19 cases, positive environmental samples, or risk of infection. In many studies it was difficult to determine a dominant route of COVID-19 transmission. However, evidence from experimental studies suggests that SARS-CoV-2 can remain viable in airborne aerosols potentially for hours and advected by air currents over longer distances (>2 metres). The airborne route appeared to play a significant role in crowded and confined indoor environments where people spend a significant amount of time, such as churches, call centres, restaurants, and meeting rooms. Ventilation and vocalization patterns affected the risk of airborne transmission. The aerosol transmission distance could not be accurately determined because of the unknown minimal infectious dose. The use of suitable sampling methods remains an important challenge particularly for real-time airborne detection of SARS-CoV-2. Mathematical modelling and visualisation studies have investigated dispersion of respiratory droplets and aerosols based on a range of simplifying assumptions. The integration of

environmental sampling, mathematical modelling, visualisation, and epidemiological methods can contribute to improved design of COVID-19 protective measures related to social distancing, indoor ventilation, and use of personal protective equipment.

Keyword:COVID, aerosol, environmental health, airborne transmission

1054376

Changes of exposure factors in daily consumption life after COVID-19 pandemic in Korea

M. Lim[1], K. Lee[2]; [1]Institute of Health and Environment, Seoul National University, [2]Graduate School of Public Health, Seoul National University

Abstract: The Coronavirus Disease-19 (COVID-19) pandemic is prolonging worldwide. 'Social distancing' was implemented to reduce face-to-face contact with others, and the patterns of daily consumption life also changed. This study determined the exposure factors for time spent by locations, use of sanitizer products, and intake by food containers during COVID-19 outbreak, and compared it with the exposure factors before COVID-19 outbreak. In July 2020, an online survey was conducted on 1,000 subjects over 19 years old in Korea by proportionate quota sampling considering sex, age, and regional distribution. The exposure factors of daily time spent by locations (own home, workplace/school, transportations, other locations), use frequency and use amount of 4 sanitizer products (hand wash foam, hand sanitizer gel, disinfectant spry, disinfectant wipe), and intake rate of 5 food container types (cup noodles packaging food, paper packaging food, vinyl packaging food, plastic packaging food, canned food) were collected. The calculated exposure factors were compared to the exposure factors derived from a home-visit survey of 1,001 subjects in Korea using same sampling methods and questionnaire in 2017. In 2020, the average time spent at workplace/school (6.2±4.2 hrs/day) and other locations (1.7±1.6 hrs/day) were decreased significantly ($p \leq 0.0001$) compare to 2017. The average time spent at own home (12.0±4.9 hrs/day) was no statistical difference compared to 2017. The use rates of sanitary products were 95% of hand sanitizer gel, 89% of hand wash foam, 64% of disinfectant wipe, and 58% of disinfectant spray. The use of had wash foam and hand sanitizer gel increased significantly in both the use frequency ($p \leq 0.0001$) and use amount ($p \leq 0.05$) compared to 2017. The average intake frequency by food container was 1.3–2.6 events/week, and all values increased significantly ($p \leq 0.0001$) compared to 2017. The exposure factors during the COVID-19 pandemic could be a useful component of exposure and risk assessment to hazardous chemicals in consumer products.

Keyword:COVID, exposure factors, consumer and personal care products

1054301

Solutions for a Changing World: Understanding the Impacts of the COVID-19 Pandemic on Small Businesses in Latino Communities

J. Honan[1], M. Ingram[2], L. Stauber[2], F. Sandoval[3], C. Quijada[2], M. Chaires[2], R. Spitz[3], J. Fimbres[2], A. Yubeta[4], J. Varela[4], A. Wolf[3], P. Beamer[2]; [1]The University of Arizona

Department of Community, Environment, and Policy, [2]The University of Arizona, [3]Sonora Environmental Research Institute, [4]El Rio Health

Abstract: The COVID-19 pandemic has simultaneously exacerbated and elucidated inequities in resource distribution for small businesses, both in terms of health and economic disparities. This is especially true for those that are owned or managed by people of color, and more so for those who primarily speak a language other than English. To better understand how the pandemic has influenced minority-owned small businesses and their employees, a longitudinal survey tracked how business practices, perceptions of risk, and risk-related decision-making changed during the pandemic. Owners, managers, and workers in the beauty and auto shop sectors were recruited from predominantly Latinx communities in the Tucson and South Tucson metropolitan areas to take part in this survey. These workers are exposed to volatile organic compounds (VOCs) at rates greater than those of many other industries, and due to high rates of facility disinfection during the COVID-19 pandemic, exposures have likely increased. Businesses must weigh competing risks from VOCs and COVID-19 against the subsequent loss of income from practices meant to minimize SARS-CoV-2 exposures, such as reducing client load or temporarily closing. Participants received four surveys, either by phone or online, disseminated six weeks apart over a total of five months. Because beauty salon workers interface more directly with the public than auto repair mechanics, and because beauty salon workers are predominantly female while auto shop workers are primarily male, responses were expected to vary between the two groups. Compared to auto shops, beauty salons were more likely to continue to implement exposure controls over time, such as wearing face masks and disallowing walk-ins, but were also more likely to be affected by pandemic-related issues, such as reduced client load and sourcing difficulties. Auto shops, designated by the state of Arizona to be “essential” businesses, were less likely to have experienced coronavirus-related financial precarity. Despite applying for governmental financial assistance, only one of the businesses surveyed was able to secure a Paycheck Protection Program loan. Finally, the high frequency of disinfection using products such as bleach or alcohol for both business types indicates presumably elevated VOC concentrations compared to pre-pandemic levels. These augmented disinfection practices may become commonplace for businesses in the long-term, thereby negatively impacting worker health.

Keyword:COVID, occupational exposure, community

1054510

Evaluating consumer exposure to disinfecting chemicals against coronavirus disease 2019 (COVID-19) and associated health risks

L. Li[1], A. Sangion[2], d. Li[1]; [1]University of Nevada, Reno, [2]University of Toronto Scarborough

Abstract: Disinfection of surfaces has been recommended as one of the most effective ways to combat the spread of novel coronavirus (SARS-CoV-2) that causes coronavirus disease 2019 (COVID-19). However, overexposure to disinfecting chemicals may lead to unintended human health risks. This presentation introduces a systematic investigation into consumer indoor exposure to 22 active ingredients of COVID-19 disinfectants on the lists recommended by regulatory agencies. We use an indoor fate and chemical exposure model to

estimate daily whole-body update doses through contact with disinfected surfaces, and the resulting blood concentrations, resulting from a single use of disinfectants per day for three age groups (3, 14, and 24-year-old). We also assess the health risks by comparing the predicted whole-body uptake doses with in vivo toxicological data and the predicted blood concentrations with in vitro bioactivity data. Our results indicate that consumer indoor exposure varies considerably among the disinfecting chemicals due to their diverse physicochemical properties. 3-year-old children have consistently higher exposure than other age groups due to their more frequent hand contact and mouthing activities. Exposure from contact with disinfected surfaces may result in health risks for certain age groups especially children, even the surfaces are disinfected once a day. Interestingly, risk assessments based on whole-body uptake doses and in vivo toxicological data tend to give higher risk estimates than do those based on blood concentrations and in vitro bioactivity data. Our results reveal the most important exposure routes for disinfecting chemicals used in the indoor environment; they also highlight the need for more accurate data for both chemical properties and toxicity to better understand the risks associated with the increased use of disinfecting chemicals in the pandemic.

Keyword:COVID, consumer and personal care products, exposure models

1054530

Integrated exposure and disease severity model for COVID-19 health risk management

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Abstract: The greatest challenge for the successful management of the COVID-19 long-term sanitary crisis is the effective application of targeted interventions and closing of specific activities that are considered as the ones that contribute mostly to widespread contagion. Aiming at the efficient management of the COVID-19 pandemic, we have developed a multi-modal computational tool for the evaluation of the public health risk from the COVID-19 epidemic in Greece, Italy and USA and we have evaluated the effectiveness of different non-pharmacological intervention scenarios for public health risk management. The computational tool for public health risk management from COVID-19 is called CORE: COVID Risk Evaluation model. It includes an advanced SEIR model that takes into account the implementation dynamics of non-pharmacological interventions such as virus detection testing geared towards the general population or targeted sub-population groups, circulation restriction and population containment measures, in the evolution of the dispersion and the final health risk assessment of the affected population. The model has been extended to a multi-state population model to describe in detail the different possible states of the population based on the typology and severity of the symptoms of the disease. A key component for the identification of the effect of the targeted containment measures is the ability to properly account for the effect various activities may have on the effective contact among various population groups, accounting for their sociodemographic profiles (i.e. age, occupation etc). Towards this aim, contact rates for the different population groups within the CORE model, are estimated using Agent-Based Modelling (ABM). All the above, allowed us to be able to evaluate various scenarios of containment and closing or opening of activities, supporting the efficient planning for combating COVID-19 spread dynamics. At the same

time, beyond the successful analysis of containment scenarios, we were able to predict in long term the spread dynamics and the respective burden on the health services at specific milestones, such as the impact of touristic flows on the summer and the development of the second wave in early August 2020, the effect of the variants of concern (with higher transmissibility) on the third wave in 2021, and the projections for the forthcoming summer.

Keyword:COVID, exposure models, health impact assessment (HIA)

1054543
HOME-FIT: HOmemade Masks for Everyone Fit & Improvement Testing
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Abstract: Homemade masks are commonly used as an alternative to commercial masks to protect the general public from the spread of infectious respiratory diseases such as COVID-19. The usage of masks is recognized to play an integral role in reducing droplet transmission from the wearer to others, but can also reduce airborne transmission from the surrounding environment to the wearer, when worn properly. The filtration efficiency of particles through homemade mask materials has recently been investigated in laboratory conditions by several studies. However, very little is understood concerning the influence of different mask designs and the fit of the masks on different face shapes and sizes. To investigate this critical knowledge gap, standardized quantitative fit testing has been conducted with 5 human volunteers to evaluate the fit of 50 mask designs. Tests were conducted while various exercises were performed that are representative of real-world activities. The fit of common homemade mask designs has been studied, as well as the influence of variations of nose bridges, elastic vs. tie options, and 23 material combinations. The overall fit factors (OFF) measured in this project represent the level of protection that the mask can provide members of general public and are influenced by the fit of the mask, the material filtration efficiency, and the breathability. Relative to a surgical mask by itself, double masking with a 2-layer quilt cotton mask on top of a surgical mask demonstrated only a 0.6% improvement in the average OFF, while surgical mask material layers embedded in a homemade mask resulted in a 58% increase in the average OFF and ranked 3rd out of all of the masks tested. An outer brace worn over a mask was shown to improve the average OFF of all participants by 24%. Fourteen homemade mask designs ranked higher than the surgical mask in regards to their OFF, removing between 65.5 and 81.3% of particles from the room air, eleven of which ranked higher than a KN95 mask. The pressure drop of different material combinations was also measured over a range of face velocities to evaluate the breathability of the tested masks. These results suggest that there are many homemade mask options that have the potential to provide just as much protection from the spread of infectious respiratory diseases as commercially available options.

Keyword:COVID, particles, pandemic

1054572
Socioexposomics of COVID-19: The Case of New Jersey

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Abstract:COVID-19 created an unprecedented global public health crisis due to its speed and breadth of infection, pressure on healthcare systems, and large numbers of casualties. Disease outcomes are strongly correlated with individual-level risk factors, such as age, sex and medical history, as well as with multiple, spatially heterogeneous, demographic, environmental and socioeconomic factors. In particular, racial and ethnic minorities, economically disadvantaged populations, and environmental justice communities have been disproportionally impacted by COVID-19. Prior exposures to a wide range of chemical, biological, and psychosocial stressors appear to affect susceptibilities to the disease. These facts have led to the realization that we were confronting not just a pandemic, but a syndemic, driven by complex interactions of multiple factors and conditions. Understanding and quantifying the significance of these factors and interactions requires an expansion of the approaches typically employed in exposomic studies, to include, in addition to data relevant to environmental stressors, multiple types of demographic, socioeconomic, and behavioral/lifestyle data that characterize the socioexposome. The present study focused on New Jersey for multiple reasons: New Jersey has the highest population density in the nation and was one of the earliest and largest hotspots for COVID-19 in the US, ranking first in the nation in per capita COVID-19 death rates (over 260 deaths/100,000 residents). Furthermore, New Jersey has high ethnic diversity and high spatial heterogeneity in socioeconomic, demographic and environmental factors. It has often been claimed that the 565 municipalities of New Jersey constitute a “microcosm" representative of conditions that can be encountered at diverse locations across the contiguous US. A hierarchy of statistical, geostatistical, and machine learning methods were utilized to explore and quantify associations of municipality-level health outcomes (i.e. confirmed COVID-19 cases and deaths) with a wide spectrum of metrics representing social/behavioral and environmental determinants of health at the census tract or block level. Metrics of associations derived through the local/municipality level analyses are also compared with corresponding metrics for associations derived from analyses employing county-level data for the 21 New Jersey counties and the 3,092 counties of the contiguous US, to assess effects of ignoring local heterogeneities.

Keyword:COVID, geospatial analysis/GIS, other (specify below), exposomics

1094320

The impact of COVID-19 restrictions on black carbon concentrations in San Ysidro, CA, a US-Mexico border community

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Abstract: San Ysidro, CA is a community highly impacted from its location near the US-Mexico border. The US-Mexico Port of Entry at San Ysidro, CA (SYPOE) that crosses into Tijuana, Mexico, is the busiest land crossing in the Western Hemisphere, causing the San Ysidro area to be coded in the highest traffic percentile for all of California in the CalEnviroScreen tool. In addition, open burning activities in Tijuana, visible to the San

Ysidro and nearby communities, have led to concern about toxic air pollution from combustion products of industrial and municipal waste. In March 2020, the COVID-19 pandemic caused by the novel coronavirus led to restrictions in order to reduce its spread in California. On March 21, 2020, the US severely restricted travel across the US-Mexico border, including the Port of Entry at San Ysidro, CA (SYPOE) that crosses into Tijuana, Mexico. Long wait times at the POE with extensive idling traffic increases concentrations of black carbon (BC) in the air. BC is also a marker of open burning. For this project, BC hourly data was collected at a central San Ysidro site by the San Diego Air Pollution Control District, with data provided from October 2019 to March of 2021. Overall, BC concentrations increased from pre-COVID-19 levels. The highest concentrations were during winter months. For example, in December 2020, 54% of BC hourly values were over the 2020 75th percentile of 1.36 µg/m3, significantly greater than December 2019, which had 45% of values over 1.36 µg/m3. BC concentrations tended to be at their highest during overnight hours of 2:00 A.M to 6:00 A.M. with another increase during morning rush hour. Post- COVID-19 BC concentrations for all months with comparison data (Nov 2019 – Feb 2020 vs. Nov 2020 – Feb 2021) were significantly greater than pre-COVID-19 measurements. The relationship of BC concentrations with PM2.5 measures from low-cost sensors is the next step to be investigated, to help characterize the toxicity of particulate matter in the community. The sources of elevated BC concentrations in this US-Mexico border community should be further investigated and binational efforts made to reduce pollution affecting disadvantaged communities in the region.

Keyword:air toxics, community, environmental justice

1054701

Variations in air pollution levels in Birmingham, Alabama during the COVID-19 pandemic

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Abstract: The restrictions imposed to control the spread of COVID-19 significantly limited human mobility, decreasing mobile sources of air pollution, and thereby improving air quality in many large cities. Changes in traffic volumes, variations in emissions from industries and power plants, and weather patterns can contribute to short-term and long-term air quality variations in cities. Birmingham - the largest and most populous city in Alabama, was known to have one of the worst air pollution levels in the country due to mines, industrial mills, and factories that produced and processed iron ore. However, in recent times air quality in Birmingham has improved dramatically, although still among the 15 most polluted cities in the US. Given this history of poor air quality and the lack of studies on recent air quality, the primary objective of this study was to investigate whether concentrations of selected criteria pollutants were significantly impacted during the COVID 19 pandemic in Birmingham, Alabama, compared to pre-lockdown months/years. The study primarily focused on PM2.5 and NO2 levels as they were considered markers of mobile source air pollution, which was impacted by restrictions. Daily data from 2016-2020 were obtained for the pollutants from the U.S. Environmental Protection Agency and/or the Jefferson County Department of Health air monitoring network websites and statistically compared. We found that the mean PM2.5 levels in March and April were significantly lower in 2020 compared to 2019, however, the

mean concentrations in March-April 2020 were not significantly different compared to the previous months (January-February). NO2 concentrations sharply reduced from February to March while they continued to decline, reaching their lowest in July. Overall, concentrations during the year 2020 were significantly lower than the year 2019 and air quality continued to improve from March until May in 2020. The traffic data that was obtained through the Alabama Department of Transport monitoring website demonstrated that traffic volumes declined during the lockdowns, reaching the lowest numbers in April 2020. However, they did not correlate with PM2.5 or NO2 concentrations. Further analyses on other air pollutants are being conducted to understand the contributions from other sources to Birmingham's air quality.

Keyword:air pollution, COVID, environmental health

1090369

Evaluation of two detection methods of SARS-CoV-2 in wastewater by RT-qPCR and Mass Spectrometry

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Abstract: The recent COVID-19 pandemic overwhelmed the health system worldwide, which was not prepared to effectively determine active cases within a community by large-scale individual PCR tests. Therefore, there is a need to cost-effectively and non-invasively track outbreaks in the population in response towards SARS-CoV-2. Wastewater based-epidemiology (WBE) allowed detection of the SARS-CoV-2 viral RNA in the influents of wastewaters coming from domestic sewage systems. Until now, the most used technique for this purpose has been the RT-qPCR (reverse transcription-quantitative polymerase chain reaction). This article proposes a MS-based method that specifically detects SARS-CoV-2 proteins in WW influent samples, which can forecast population changes six days ahead of the clinical case data. In addition, this study also compares the parameters affecting the RT-qPCR detection methods of the SARS-CoV-2 N1 gene and fecal strength indicator pepper mild mottle virus (PMMoV) gene. We were able to identify unique peptides of at least eight proteins related to the SARS-CoV-2 virus and COVID-19 infection. The non-structural protein pp1ab (only transcribed after host cell infection) was the protein most consistently detected in all the samples. Thus, we suspect that among the active cases of COVID-19, the pp1ab protein is present in high abundance in the urine and feces and that this protein could be used as an alternative biomarker to measure human COVID-19 infection at the population level. Our results also demonstrated that pasteurization, storage temperature, and viral concentration methods, prior to qPCR, can affect both total RNA and SARS-CoV-2 concentrations. Combined, this paper presents method recommendations for developing both protein and RNA-based methods that are a reliable, accurate, sensitive, and reproducible estimation of the SARS-CoV-2 virus in the community.

Keyword:analytical methods, COVID, other (specify below), wastewater

1054615

Modeling 8-hr inhalation exposure and risk of infection to pathogen-laden expiratory droplets in representative offices

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Abstract: Indoor inhalation exposure to expiratory emissions depends on many factors, including the room geometry, distance from emitter, ventilation rate, the use of face coverings, expiratory aerosol size distribution, and patterns of aerosol transport and deposition in the room. In this study, we compare predicted levels of 8-hr inhalation exposure to pathogen-laden expiratory droplets and the associated risk of aerosol transmission of COVID-19 within representative two-person and nine-person cubicle workspaces for a range of ventilation conditions and mitigation measures. The pathogen release is represented by a size-resolved quanta emission rate, and a computational fluid dynamic (CFD) model is used to simulate the aerosol transport with the three–equation (k-kl-□) turbulence model of Walters and Cokljat (2008). The infected droplet concentration in the office space was evaluated with a user-define-function (UDF) accounting for the turbulent diffusion and gravitational sedimentation. Reference: Walters, D.K. and Cokljat, D. (2008). A three-equation eddy-viscosity model for Reynolds-averaged Navier-Stokes simulations of transitional flows. Journal of Fluids Engineering, 130, 121401-1-14. This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

Keyword:COVID, workplace, microbial agents

1054579

What the COVID-19 Pandemic has Taught Us about Assessing Exposures to Hand Sanitizers

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Abstract: The onset of the COVID-19 pandemic in 2020 rapidly changed the lives of Canadians and people all around the world. Public health guidance lists the practice of good hand hygiene as one personal preventive practice for preventing the spread of COVID-19, including the recommendation of hand sanitizer use when soap and water are not available. As a result, the use of hand sanitizers by the general population of Canada, including children, has increased during the COVID-19 pandemic compared to pre-pandemic times. Under the Chemicals Management Plan (CMP), the Government of Canada aims to reduce the risks posed by chemicals to Canadians and their environment. Exposures across a range of sub-populations including children, adolescents and adults from substances used in personal care products (PCPs), including hand sanitizers, are estimated using information about the product and its use. Two important parameters used in exposure estimates are frequency of use and the amount of product used. Given the increased use of hand sanitizers during the COVID-19 pandemic, updated default values for frequency of use and the amount of product used are required for exposure estimates. An overview of existing defaults, as well as proposed updates to these default values as a result of the pandemic based on the available literature will be discussed. The challenges and uncertainties associated with selecting default

exposure factors for various age groups for use in human health regulatory risk assessments will also be discussed.

Keyword:consumer and personal care products, COVID, other (specify below), hand sanitizer

1054629

Self-reported COVID-19 prevalence, SARS-CoV-2 IgG antibody prevalence, and vaccination among industrial livestock operation workers and community residents, North Carolina, USA

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Abstract: Meat and poultry processing plants emerged as centers of COVID-19 outbreaks across the United States early in spring 2020. However, the extent of SARS-CoV-2 infection among livestock workers and those living proximal to livestock operations, as well as vaccine access and hesitancy in these populations, remains unclear. Testing SARS-CoV-2 antibody positivity allows for an estimate of prevalence unaffected by differences in access to SARS-CoV-2 RNA or antigen testing over time. Saliva from between gums and teeth contains antibodies that leak from the blood and can support non-invasive “sero”-surveillance of recent and past SARS-CoV-2 infection using at-home sample self-collection. We hypothesized that industrial livestock operation (ILO) workers and their household members would have higher prevalence of self-reported COVID-19 and SARS-CoV-2 antibody positivity, but lower prevalence of SARS-CoV-2 PCR test positivity and COVID-19 vaccination compared to community residents living proximal to ILOs and urban residents. This work represents a preliminary analysis within an ongoing study in North Carolina, the 2nd leading hog and turkey and 5th leading broiler chicken producing state. We have enrolled 6 of a planned 100 ILO households with at least one adult working at an industrial hog or poultry operation, meatpacking plant, or animal rendering plant, 22 of 100 ILO neighbor (ILON) households without occupational livestock exposure, and 35 of 100 households in urban areas (Raleigh/Durham, Wilmington, Greensboro) between Feb 23 and May 7, 2021. All household members of any age were eligible. Participants completed a questionnaire and collected biospecimens using a mailed or dropped off sampling kit with phone or video call guidance. More ILO participants reported thinking they had COVID-19: 50%, compared to 26% ILON (p=0.24) and 21% urban (p=0.11). Similar proportions across groups reported receiving a COVID-19 vaccine and completing the vaccination course. Saliva samples were analyzed for IgG specific to SARS-CoV-2 using a multiplex enzyme immunoassay, and 23/46 tested positive: 50% ILO, 58% ILON, and 43% urban. More ILO participants were nucleocapsid positive (suggesting SARS-CoV-2 infection, not vaccination only): 33%, compared to 21% ILON (p=0.6) and 28% urban (p=1). Self-reported COVID-19 and antibody results suggest high rates of exposure to SARS-CoV-2 among all participants and illustrate the feasibility of remote and self-collection surveillance methods.

Keyword:COVID, occupational, biomarkers

1054661

Fine scale COVID-19 case clusters in Massachusetts, USA: a space-time cube analysis

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Abstract: Introduction: Studies of COVID-19 spatial and temporal trends have been used to identify and understand risk factors for spread within and between communities. The majority of these studies have utilized coarse spatial resolution data (i.e., county), which may miss important within-county and within-community heterogeneity, valuable in implementing targeted interventions. In this study, we utilized geocoded individual case data in Massachusetts and applied novel statistical methods to investigate the spatial and temporal patterns of COVID-19 and identify hot/cold spots during two outbreak waves. Methods: We obtained address-level data for all confirmed COVID-19 cases in Massachusetts from March 2020 to February 2021 (n = 470,432). Local outlier analysis and emerging hot spot analyses were performed to analyze the spatiotemporal clustering pattern and cold/hot spot trends of COVID-19 cases based on space-time cube (STC). Rolling three-week average COVID-19 case incidence rates were used to generate snapshot city and town-level (n=351) hotspot maps for each wave (Wave-2: November 1st 2020 – February 12th, 2021of the COVID-19 outbreak. STCs were also developed for each wave of COVID-19 at 1 km x 1 km grids with a three week time period that matched the town-level analysis. Results: STCs demonstrated differences in the spatiotemporal patterns of COVID-19 between the first and second waves, with more rapid case acceleration and more widespread spatial hot spots during the second wave. The spatiotemporal distribution of cases was uneven in rural areas with sporadic or isolated consistent hotspots in areas with long-term care facilities, while a consistent or oscillating positive trend was observed in more urban areas. Conclusions: By applying STC to geocoded COVID-19 case data, we created robust visual insights about the changing spatiotemporal patterns of disease, and identified local hot and cold spots which crossed town/city boundaries. Formal integration of space-time modeling with surveillance systems with fine scale data would strengthen prevention and control efforts by departments of public health, helping to identify locations to target interventions (i.e. vaccination or testing sites), as well as refining studies to identify risk factor of spread during a rapidly evolving pandemic.

Keyword:COVID, geospatial analysis/GIS, infectious disease

1054677

Screening assessment for presence and risk of phthalates in fabric face coverings

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Abstract:U.S. Consumer Product Safety Commission (CPSC) reports and peer-reviewed articles indicate that various phthalates could be present in toys, clothing items, and other

textiles. Thus, the potential presence of phthalates in motifs, coated fabrics, plastisol prints, and buttons is an important consideration for textile retailers and manufacturers. Specifically for childcare articles, such as those placed in one's mouth, the maximum limit for individual phthalates or sum of phthalates has been set to 0.1% (w/w) in the U.S., Canada, E.U., Denmark, South Korea, China, and Taiwan. To the best of our knowledge, there are currently no regulatory limit set for adult clothing articles. Many local, regional, or national agencies have encouraged or mandated the use of face coverings in public places to mitigate the spread of COVID-19. Owing to the rapid increase in demand from these measures, fabrics used in traditional clothes-making (e.g., shirts, leggings) have been converted for use to make face coverings. However, to the best of our knowledge, no studies have evaluated the potential presence of and subsequent exposure to phthalates in various fabrics used to manufacture face coverings. Consequently, using available literature data, this study aimed to 1) characterize potential phthalate concentrations in fabric face coverings of various types of textiles, and 2) perform a "worst-case" screening assessment to estimate potential risks to consumers. To estimate phthalate concentrations in masks and quantify potential exposure, we surveyed masks available at retailers across California in November 2020 to estimate average mask dimensions. Exposures in adults and children via inhalation, direct dermal, and dermal air gap were calculated, assuming an exposure of 8 hours per day. We found that the predominant contributor (> 50%) of predicted daily phthalate exposures was via direct dermal pathway. The predicted inhalation and dermal doses are several orders of magnitude lower than precautionary health-based guidelines (e.g., for DnBP, DiBP, and DEP), indicating that exposure to phthalates from wearing fabric-based masks does not pose a health risk to consumers. It followed from our analysis that the 0.1% regulatory limit set for childcare articles appears to also be adequately protective for children and adult face masks. Future sample analysis of commercially marketed face masks may be useful to increase confidence in our literature-based screening methods.

Keyword:COVID, phthalates, risk assessment, fabric face coverings

1043022

The impact of COVID-19 stay-at-home orders on personal chemical exposures

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Abstract: The COVID-19 pandemic has shaken the world, affecting every facet of society. Many countries have implemented preventative public health practices to prevent transmission of SARS-CoV-2 including stay-at-home orders, face mask uses, physical distancing, hand hygiene, and recommendations for surface cleaning/disinfection. The extensive and intensive use of cleaning and disinfectant products focused on fomite transmission coupled with remote school/work might alter the diversity and magnitude of environmental chemicals to which individuals were exposed. The objective of this study was to use the wearable passive air sampler (FreshAir wristband) and examine whether chemical exposures in children have changed during the COVID-19 pandemic. We compared the personal exposures to airborne environmental contaminants among six children aged 8-15 years living in New Haven, Connecticut assessed once before the COVID-19 pandemic (October 2019-January 2020) and again during the pandemic (August 2020-October 2020).

Paired wristband samples were analyzed using thermal desorption gas chromatography high-resolution Orbitrap mass spectrometry with targeted and suspect screening data processing workflows. We assigned the use categories of identified environmental contaminants according to the CompTox Chemicals Dashboard, an EPA free online database. Out of a total of 76 targeted analytes we assessed, 18 chemicals were detected in at least half the wristband samples collected. Among the quantified chemicals, phthalates and polycyclic aromatic hydrocarbons (PAHs) had the highest exposure concentrations. The PAH exposures concentrations were on average 67% lower before the pandemic while no apparent difference was observed for phthalates. In addition, we used our suspect screening workflow to evaluate the diversity of chemical exposures. We identified 639 high confidence compounds, spanning from 12 categories including cosmetics, pesticides, food/vitamins, flavorants, fragrances, pharmaceuticals, combustion, surfactants, dyes, and flame retardants. In exposure cluster network analysis, we found that exposures from pharmaceuticals, pesticides, flavorants, and fragrances were higher before the pandemic while no changes were observed for the levels of acetaldehyde and triclosan associated with cleaning/disinfectant products and hand sanitizers. Our findings suggest that the diversity and magnitude of childhood environmental exposures have changed because of the COVID-19 pandemic.

Keyword:COVID, air sensor, other (specify below), personal exposures, passive air samplers, personal care products, consumer products

1047965

Ultrafine particle concentrations in a neighborhood near a major airport before and during the COVID-19 pandemic

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Abstract: Introduction: As a result of the COVID-19 pandemic and subsequent travel restrictions and other reductions in mobility in the United States, emissions from the transportation sector decreased dramatically. While travel has gradually increased since the initial months of the pandemic, it remains below pre-pandemic levels. The air quality implications of the shifts in both road traffic and aviation activity have not been well characterized. Ultrafine particle (UFP; particles <100 nm) emissions are predominantly from the transportation sector and have complex atmospheric dynamics. The aim of our study was to leverage a set of UFP measurements in a community near a major airport across multiple years to evaluate time trends and contributions from transportation sources. Methods: UFP was measured as particle number concentration (PNC) using a condensation particle counter. PNC was collected at a fixed site in the urban community of Chelsea, MA over two monitoring periods: 1) before the pandemic (January 2017 – September 2018), and 2) during the pandemic (April 2020 – February 2021). We compared measurements collected during the pandemic with the corresponding months before the pandemic to control for seasonality. We computed differences in median and 95th percentile PNC for two time period comparisons: Early Pandemic (April – August 2020) and its corresponding pre-pandemic

baseline period (April – August 2017; April – August 2018), and Late Pandemic (September 2020 – February 2021) and its corresponding pre-pandemic baseline period (September 2017 – February 2018). Results: We found that median and 95th percentile PNC fell 46% and 51%, respectively, during Early Pandemic as compared to baseline, but that median and 95th percentile PNC increased 6% and 11%, respectively, during Late Pandemic as compared to baseline. These findings are under the conditions that flight activity and statewide traffic volumes were approximately 50% and 20% lower in the Late Pandemic than their corresponding pre-pandemic levels. Conclusions: Our results indicate that the short-term and long-term air quality impacts of the COVID-19 pandemic are challenging to decipher, especially for ultrafine particles given their spatial and temporal behavior, reinforcing the importance of long-term monitoring of PNC to capture interannual differences.

Keyword:air pollution, COVID, big data

1043121

Evaluating Mitigation Strategies to Protect Hospital Workers and Reduce SARS-CoV-2 Transmission to Families

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Abstract: Background Healthcare workers have experienced high rates of COVID-19 infections and death since the start of the pandemic, suggesting incomplete efficacy of workplace infection control measures to prevent exposure to SARS-CoV-2, the virus that causes COVID-19. Less attention has been given to the spread of the virus from the workplace to household members of this frontline workforce. The aims of this pilot study are to understand whether and/or how SARS-CoV-2 is transmitted from the workplace of health care workers into their home environment and to develop an educational module to prevent work to home transmission. Research methods We conducted a cross-sectional questionnaire-based study in January 2021. We enrolled Boston Medical Center employees of various patient-facing and non-patient-facing roles and clinical trainees (n=248) to characterize hospital workers' transmission mitigation efforts and household-level COVID-19 risk. We also developed an online educational module on strategies to prevent SARS-CoV-2 transmission from work to home based on a literature review and an expert review. Key finding and conclusions Of the 60 survey respondents who reported that they had a confirmed or suspected COVID-19 infection since March 2020, 48% (n=29) believed that they contracted the virus at the hospital. Thirty-eight percent (n=11) of those who believed that they acquired COVID-19 from work reported having at least one household member who then developed a similar illness. Scarce PPE early in the pandemic and co-workers not adhering to infection prevention measures particularly in non-clinical situations were cited as major challenges to preventing exposure in the workplace. Interventions to mitigate household risk included changing clothes and shoes before arriving home, self-isolation, disinfection of surfaces, and modifying behaviors around eating, sleeping, and use of shared

bathrooms. The online module aims to address the diverse work and housing situations of hospital workers by offering evidence-based recommendations to prevent the spread of the virus using a simple checklist format. An evaluation of the module will aim to address the relevance, feasibility, and acceptability of the intervention. By considering hospital workers' logistical and psychosocial challenges to keeping their household members safe during the pandemic, this module may help to lower the risk of SARS-CoV-2 transmission and other infectious diseases in urban communities.

Keyword:COVID, occupational exposure, other (specify below), Households

1049065
Increased Human Exposure to Quaternary Ammonium Compounds during the COVID-19 Pandemic
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Abstract: Quaternary ammonium compounds (QACs or "quats") are a class of chemicals used as disinfectants in cleaning and other consumer products. While disinfection is recommended for maintaining a safe environment during the COVID-19 pandemic, the increased use of QACs is concerning as exposure to these compounds has been associated with adverse effects on reproductive and respiratory systems. We have determined the occurrence of 19 QACs in residential dust collected before and during the COVID-19 pandemic. QACs were detected in > 90% of the samples collected during the pandemic at concentrations ranging from 1.95-531 μg/g (n = 40, median 58.9 μg/g). The total QAC concentrations in these samples were significantly higher than in samples collected before the COVID-19 pandemic ($p < 0.05$; n = 21, median 36.3 μg/g). Higher QAC concentrations were found in households that have increased their cleaning routine during the pandemic and in those that generally disinfected more frequently ($p < 0.05$). We have also measured these QACs in human blood collected before and during the pandemic (serum). Fifteen out of the 18 targeted QACs were detected in blood collected during the pandemic with the total QAC concentrations ranging from 0.453 to 68.6 ng/mL (median 6.04 ng/mL). These QAC concentrations were significantly higher than those measured in samples collected before the pandemic (range 0.573-13.8 ng/mL, median 3.41 ng/mL). Overall, there was a 77% increase in the total QAC concentrations measured in the samples collected during the pandemic compared to that in the pre-pandemic samples. This is the first comprehensive study on the indoor exposure and biomonitoring of the three major QAC groups and our findings indicate that indoor exposure to QACs is widespread and has increased during the pandemic.

Keyword:COVID, built/indoor environment, biomonitoring

1042745
The controlling of COVID-19 in Thailand.
K. Tantrakarnapa; Mahidol University

Abstract: Coronavirus disease (COVID-19) has been identified as a pandemic by the World Health Organization (WHO). It has caused many deaths and the number of infections became

greater than 130 million as of 1 April 2021. This paper aims to analyze the situation of COVID-19 in Thailand, the association influencing factors of spreading and the challenging disease control. We employed a statistical technique to analyze the ambient temperature and economic influencing the cases. We found that temperature was significantly associated with daily infected cases (p-value <0.01). The movement of people, both in relation to local (Thai people) and foreign travel (both Thai and tourists), played a significant role in the spread of COVID-19 in Thailand. The number of infected cases was significantly associated (correlation coefficient > 0.7) with the economic factor, namely; the number of visitors generated income from both Thai and foreign tourist (p-value <0.01). The influencing factors of slow increased rate were the enforcement and implementation of both central and local government regulation, the strength of the Thai health care system, the culture and social relation, the partnership among various governmental and private sectors. Enforcing a state of emergency and regulating social distancing were the key factors in reducing the growth rate of the disease. The implementation of interventions, such as government regulation and restrictions, through collaboration among various sectors, was the key factor for controlling the spreading of COVID-19 in Thailand.

Keyword:COVID, public health, infectious disease

1053064

Transmission of COVID-19 and other infectious diseases in washrooms: a systematic review

S. Vardoulakis[1], D. Espinoza Oyarce[1], E. Donner[2]; [1]Australian National University, [2]University of South Australia

Abstract: Background: The risk of infectious disease transmission in public washrooms causes concern particularly in the context of the COVID-19 pandemic. This systematic review aimed to assess the risk of transmission of viral or bacterial infections through inhalation, surface contact, and faecal-oral routes in public washrooms in healthcare and non-healthcare environments. Methods: We systematically reviewed environmental sampling, laboratory, and epidemiological studies on viral and bacterial infection transmission in washrooms published in the peer-reviewed literature using the PubMed and Scopus databases. The review focused on indoor, publicly accessible washrooms. Results: Thirty-eight studies from 13 countries were identified, including 14 studies carried out in shared toilets in healthcare settings, 10 in laboratories or experimental chambers, and 14 studies in restaurants, workplaces, commercial and academic environments. Thirty-three studies involved surface sampling, 15 studies air sampling, 8 studies water sampling, and 5 studies were based on risk assessment or outbreak investigation. Infectious disease transmission was mainly studied in relation with: (a) toilets with flushing mechanisms; (b) hand drying systems; and (c) water taps, sinks and drains. A wide range of enteric, skin and soil bacteria and enteric and respiratory viruses were identified in public washrooms, potentially posing a risk of infection transmission. Studies on COVID-19 transmission only examined washroom contamination in healthcare settings (mainly in respiratory isolation wards in hospitals). Conclusion: Open-lid toilet flushing, ineffective handwashing or hand drying, substandard or infrequent surface cleaning, blocked drains, and uncovered rubbish bins can result in

extensive bacterial and/or viral contamination in washrooms. However, only a few cases of infectious diseases mostly originating from washrooms in restaurants were reported. Although there is a risk of pathogen aerosolisation from toilet flushing and the use of hand drying systems, we found no evidence of airborne transmission of enteric or respiratory pathogens, including COVID-19, in public washrooms. Appropriate hand hygiene, surface cleaning and disinfection, and washroom maintenance and ventilation are likely to minimise the risk of infectious disease transmission in these environments.

Keyword:COVID, aerosol, infectious disease, surface contamination

1053588
Compliance with mask policy on a large US college campus
K. Burnell, E. Wells; Purdue University

Abstract: Institutions have implemented protocols to slow the spread of COVID-19; however, there are limited data reflecting their effectiveness. The purpose of this study was to determine mask compliance at a large public US university, where policy required wearing cloth masks inside campus buildings. This was a covert observational study. Observers were stationed inside or outside frequently traveled locations on campus during fall 2020. For each person within viewing distance, data were collected on location, date, mask compliance (yes, no), student status (student, nonstudent, unknown) and gender (male, female, unknown). Logistic regressions were used to determine predictors of mask compliance, adjusting for clustering by observation session. A total of 24 hours of observations were completed, with N=7237. Overall compliance was 90.6% (95% confidence interval (CI): 89.9, 91.3). In unadjusted comparisons, men had a significantly lower compliance rate compared to women (odds ratio (OR): 0.67, 95% CI: 0.56, 0.80). The student compliance rate was higher than non-students (OR: 1.47, 95% CI: 0.97, 2.17). Mask compliance was also significantly higher among those observed inside versus outside (OR: 3.61, 95% CI: 2.36, 5.51). Compliance was lower at the student union compared to an educational building or athletic complex. In a regression model including all collected variables as covariates, women (vs. men), inside (vs. outside) and being at the athletic complex (vs. student union) were statistically significant predictors of increased mask compliance. While there were characteristics that significantly influenced higher mask compliance, the overall mask compliancy rate was very high during this study.

Keyword:COVID, public health, policy

1053442
Indirect occupational exposure to pathogen-laden aerosols of healthcare workers during the COVID-19 pandemic
L. Liu; Department of Building Science, Tsinghua University

Abstract: Healthcare workers(HCWs) face the primary infection risk when a highly-transmissible disease emerged. Current understanding occupational exposure of HCWs to pathogen-laden aerosols is based on qualitative impression of medical practice. Direct

exposure during aerosol generating procedures are obvious and demanding for high-level personal protection equipment. Low-concentration pathogen-laden aerosols follow indoor airflows lead to indirect exposure and potential infection over a longer time span. Quantitative exposure assessment is therefore urgent to understand the risk in every typical waiting, diagnostic and treatment environment in hospitals and clinics. Our study presents three examples in ophthalmology, gastroscopy and ICU. Both HCWs' direct and indirect exposure were visualized and quantified. Effect of mitigation methods were examined and long-term environment monitoring and alarm strategy has been implemented.

Keyword:COVID, occupational exposure, pandemic

1053496

COVID-19 and Car free Day: A natural experience in black carbon and particulate matter emissions under a reduced transportation profile in Kigali, Rwanda

E. Kalisa, M. Adams; University of Toronto Mississauga

Abstract: Very little air pollution information is available for the continent of Africa and the country of Rwanda. Rwanda has experienced rapid urbanization and population growth in recent years. The use of diesel engines can be inevitably led to the release of diesel soot, including black carbon (BC) and particulate matter (PM2.5). Rwanda established an innovative policy of 'Car-Free' days where major streets are closed for two days per month to vehicles and motorcycles and open them for collective exercise sessions. In March 2020, Rwanda also imposes Africa's first lockdown because of the COVID-19. This study uses the natural experiment of the COVID-19 lockdown and car-free days policy to investigate the role of transport as a source of air pollution in Kigali, Rwanda. After controlling for the weather and seasonal variability, results indicated that both PM2.5 and BC were reduced by more than 20% on car-free days and more than 30% during COVID-19 lockdown. The results suggest that transport is a major contributor to urban air pollution in Kigali. As lockdown restrictions loosen and regular activity resumes, it is expected that air pollution levels will continue to increase in Rwanda.

Keyword:air pollution, COVID, other (specify below), Car free- day

1054283

Everyone can sample for airborne viruses using these new samplers, yes everyone!

D. Heskett, T. Jamison, P. Keady, B. Annis, T. Gordon, B. Stump, T. Xiong; Aerosol Devices Inc

Abstract: Well into the second year of the COVID-19 pandemic, researchers continue to learn about SARS-CoV-2 progress that has been facilitated by the development of new, more effective tools for sampling airborne viruses. Over the past year, many researchers have used Condensation Growth Tube (CGT) bioaerosol samplers from Aerosol Devices Inc. to investigate SARS-CoV-2. The first-generation Bio-SPOT, the Bio-SPOT VIVAS, was used in a key publication that first proved that infectious SARS-CoV-2 exists as aerosol. Aerosol Devices continues to innovate and refine CGT collection, developing tools that are portable

and easy to use. Enabling both researchers and non-research professionals to sample airborne viral particles and other pathogens with unprecedented collection efficiency. This presentation will review the patented CGT technology and summarize the various commercially-available instruments for bio-applications, citing recent publications and presentations. We also discuss recent optimization efforts that have led to a new portable CGT instrument for broader use, including testing in industrial environments, nursing homes, medical offices, and other public settings. Mr. Dominick Heskett, BSME, is the lead developer of the portable range of aerosol sampling instruments and an alumnus of the University of Colorado, Boulder. We will demonstrate the simplicity of the new BioSpot-GEM™ portable bioaerosol sampler in operation and share customer data comparing the new sampler with other common samplers.

Keyword:sampling methods, COVID, built/indoor environment

985801
Collaborative training development for emergency medical services (EMS) personnel and subsequent quantitative microbial risk assessment
A. Wilson; University of Utah

Abstract: In Spring 2020, public health researchers worked with the Tucson Fire Department and the Western Region of Public Health Training Center to develop a training for mitigating emergency medical service personnel's exposures to highly infectious pathogens. During observations and filming of mock care for a patient with COVID-19-like symptoms, personal protective equipment (PPE) donning/doffing and hand hygiene errors were observed. These errors were used to inform the development of a risk mitigation checklist along with the training video, which received more than 6500 views in the first 4 days. The process of developing this training informed the need for a risk assessment to estimate the potential COVID-19 risks EMS workers face and the risk reductions offered by masks and respirators for EMS staff and their patients. An exposure model was developed to estimate infection risks and to evaluate the relative contributions of the fomite and aerosol transmission routes to risk.

985801
Can orchestras perform safely during a pandemic? A case study using CFD to model airborne viral transport
T. Saad; Chemical Engineering, University of Utah

Abstract: The Covid-19 outbreak and ensuing shutdown have caused a significant impact on the economic productivity and well being of everyone around the world. The "creative" economy was particularly impacted - with the performing arts industries, such as choirs and orchestras, being the most affected with estimated losses of almost 1.4 million jobs and $42.5 billion in sales. While masking can be an effective strategy to inhibit the spread of the virus in the general population, it is impractical to mask wind instruments and vocalists. In May 2020, the Utah Symphony approached our team to better understand if modeling can help in developing a Covid-19 mitigation strategy for them. Because Covid-19 is primarily spread via respiratory aerosol emissions, modeling its transport using CFD can be part of a general

risk mitigation strategy. In this talk, I will discuss how we used high resolution CFD calculations along with concentration transport to model the dispersion of wind-instrument emissions for the Utah Symphony at Abravanel Hall and Capitol Theater. Our proposed mitigation strategies included (1) changing the air flow by manipulating the HVAC, opening doors, and building ducts to reroute the air, and (2) rearranging the orchestra. This resulted in an effective reduction of particle concentration by a factor of 100 in the breathing zone of the stage area. Our work shows that risk mitigation of pathogen transport is not complete without a detailed understanding of the fluid dynamics and droplet transport at a given venue.

985801

Transport risk assessment for covid knowledge (TRACK)

M. King; School of Civil Engineering, University of Leeds

Abstract:TRACK is a multidisciplinary project designed to address knowledge gaps around COVID-19 transmission on public transport. TRACK will develop a novel risk model that can simulate infection risk through three transmission mechanisms (droplet, aerosol, surface contact) within different transport vehicles. New data will be collected on public transport in three UK cities: • Air and surface samples will be collected to measure SARS-Cov-2 prevalence together with other human biomarkers as a proxy measure for pathogens. • User and staff travel behaviour and demographics will be characterised through surveys and passive data collection to relate public transport use to geographic and population sub-group disease prevalence. • The proximity of people and their surface contacts will be quantified through analysis of transport operator CCTV data to enable simulation of micro-behaviour in the transport system. • The dispersion of infectious droplets and aerosols with different environmental infection control strategies will be evaluated using physical and computational models. Data sources will be combined to develop probability distributions for SARS-CoV-2 exposure and simulate transmission risk through a Quantitative Microbial Risk Assessment (QMRA) framework. Working closely with Department for Transport and transport operators, TRACK will provide microbial and user data, targeted guidance and risk planning tools that will directly enable better assessment of infection risks for passengers and staff using surface public transport networks, and help policy teams design effective interventions to mitigate transmission.

985801

Academic debate about COVID-19 transmission: Source, pathway, receptor as a means for evaluating transmission route evidence

R. Jones; Department of Family and Preventive Medicine, University of Utah

Abstract: The primary routes of person-to-person transmission of respiratory infectious diseases are: airborne, contact, and droplet. This paradigm emerged in the mid-20th century, and reflected the evidence-base available at the time. Subsequent decades of technological advances and research have identified numerous limitations in this paradigm. In particular evidence that has emerged in the past two decades has demonstrated that the distinction between airborne and droplet transmission is blurred, perhaps even false. This has led to the suggestions of alternative paradigms such as aerosol transmissible diseases, short-rate airborne routes, small particle aerosol transmission and opportunistic transmission. This debate became highly prominent in the scientific community and among the general public

during the COVID-19 pandemic. The classification of disease transmission routes is not an esoteric academic debate, but has meaningful implications for how disease transmission is prevented in healthcare settings and in a wide array of other workplaces and public settings. Specifically, the transmission route of an infectious disease guides the selection of control strategies, and incorrect assessment of the transmission route means that controls will be less effective than they could be. One approach to investigating evidence for a specific transmission route is to consider 3 components of transmission by which an infected individual infects another: source, pathway, receptor. Here we give examples of evaluating evidence for aerosol and fomite transmission of COVID-19 using this approach.

1001513
Killing the COVID with Light Ions and Chemical Methods; What's best for your Bus
B. Buckley; Rutgers University

Abstract:A review of multiple methods for disinfection deactivation, the most effective means for keeping the bus safe for the riders of NJ Transit in the age of COVID . Covering all the current and "future" commercial methods for COVID mitigation and their mechanisms of action. The presentation will also discuss the various testing protocols for COVID and its surrogates in environmental matrices

1001513
How existing technologies and capabilities were adapted to deal with COVID mitigation strategies
B. Buckley; Rutgers University

Abstract:TBD

1001513
COVID, more than lawless bioaerosols but arrested (mitigated) just the same
G. Mainelis; Rutgers University ENS

Abstract:A description of the process of bioaerosol generation and the ways to trap it, filter it, inactivate it. The presentation will also cover the efficacy of surrogates other virus' bacteria and salt particles as models for COVID in testing mitigation strategy efficacy.

1001513
COVID comes to HAPIN, An international perspective
D. Barr; Emory University

Abstract: We will discuss our COVID work in out HAPIN Thai cohort. This population is already part of a study looking at improving the air quality in home in Hapin Thailand, that is replacing coal, crop waste and dung with liquefied natural gas used for cooking. The indoor air quality is a potential source of exacerbation, increasing susceptibility or severity of COVID.

1001513
COVID in the home, can your commercial air cleaner make your home safer?

H. Kipen; School of Public Health

Abstract:A NIEHS supplement was awarded to study the efficacy of portable air cleaners to reduce the viral load in the air in the homes of patients with COVID. The results of this study demonstrate the efficacy of these air cleaners to remove SARS-CoV-2 from the breathing environment of the household. Implications for the safety of those providing care to the infected will be presented. Testing for SARS-CoV-2 from filter and wipe samples will also be discussed.

995746

Exposome-based public health interventions for infectious diseases in urban settings

K. Makris; Cyprus University of Technology/Cyprus International Institute for Environmental and Public Health

Abstract: The COVID-19 pandemic placed public health measures against infectious diseases at the core of global health challenges, especially in cities where more than half of the global population lives. SARS-CoV-2 is an exposure agent recently added to the network of exposures that comprise the human exposome, i.e. the totality of all environmental exposures throughout one's lifetime. At the same time, the application of measures to tackle SARS-CoV-2 transmission leads to changes in the exposome components and in characteristics of urban environments that define the urban exposome, a complementary concept to the human exposome, which focuses on monitoring urban health. This work highlights the use of a comprehensive systems-based approach of the exposome for better capturing the population-wide and individual-level variability in SARS-CoV-2 spread and its associated urban and individual exposures towards improved guidance and response. Population characteristics, the built environment and spatiotemporal features of city infrastructure, as well as individual characteristics/parameters, socioeconomic status, occupation and biological susceptibility need to be simultaneously considered when deploying non-pharmacological public health measures. Integrating individual and population characteristics, as well as urban-specific parameters is the prerequisite in urban exposome studies. Applications of the exposome approach in cities/towns could facilitate assessment of health disparities and better identification of vulnerable populations, as framed by multiple environmental, urban design and planning co-exposures. Exposome-based applications in epidemics control and response include the implementation of exposomic tools that have been quite mature in non-communicable disease research, ranging from biomonitoring and surveillance to sensors and modeling. Therefore, the exposome can be a novel tool in risk assessment and management during epidemics and other major public health events. This is a unique opportunity for the research community to exploit the exposome concept and its tools in upgrading and further developing site-specific public health measures in cities.

995746

Increased exposure to disinfectants and pesticides during COVID-19 – a case study

A. Rule; Johns Hopkins Bloomberg School of Public Health

Abstract: Abuse of cleaning products brought about by COVID-19

995746

Associations between municipality socio-economic index and COVID-19 incidence and outcomes, Italy, 2020

A. Mateo-Urdiales; 1. Department of Infectious Diseases, Istituto Superiore di Sanità

Abstract: There are contradictory results about the impact of COVID-19 pandemic on different socioeconomic groups. In this study we used data from the Italian epidemiological surveillance system of COVID-19 to analyse the association between area-level deprivation and three COVID-19 outcomes -incidence, case-hospitalisation and case-fatality- during pre-lockdown, lockdown and post-lockdown. We found higher incidence of COVID-19 in the most deprived municipalities compared with the least deprived ones during lockdown and post-lockdown, but not during pre-lockdown. We did not find differences in case-hospitalisation or case-fatality according to deprivation in any period.

995746

Global and regional impact of COVID-19 response policy on air quality

J. Zhang; Department of Public Health, University of Copenhagen

Abstract: The dynamic and diverse COVID-19-response non-pharmaceutical interventions (NPIs) were widely implemented across countries and brought huge impacts to anthropogenic activities and air quality. In this study, we linked cross-country comparative NPIs policies analysis and nitrogen dioxide concentration data from both satellite observation and ground monitoring sites, and assessed the nitrogen dioxide changes due to the implementation of different NPIs implementations, adjusting for meteorological variables and time trends. We found a 32% reduction of NO2 concentration under stringent NPIs recorded by ground monitoring sites and a 5% reduction recorded by satellite. Besides, we found most nitrogen dioxide reductions were clustered around the Mediterranean, East, and South Asia, and there was a slight increase in Europe.

995746

Physical distancing due to the COVID-19 pandemic and exposome changes in the general population of Cyprus: The Exposome@Home|COVID-19 study

X. Andrianou; Cyprus International Institute for Environmental and Public Health

Abstract: The presentation will assess changes in the exposome of the general Cypriot population during the implementation of physical distancing and lockdown measures implemented in mid-March 2020 and afterwards, and ii) it will also describe the degree of compliance to the implemented measures of restricted mobility using the exposome concept..

DISASTER RESPONSE RESEARCH

1054575

Use of wildfire smoke indicators in health exposure research: high spatial resolution mapping of PM2.5 in California

N. Pavlovic[1], L. Li[2], C. McClure[1], F. Lurmann[1], R. Habre[2]; [1]Sonoma Technology, Inc, [2]University of Southern California

Abstract: Wildfire smoke is a leading driver of acute exposure to PM2.5 in the American

West and a significant contributor to chronic pollution exposure in immediately impacted and further downwind areas. Exposure to wildfire smoke is linked to acute respiratory morbidity and all-cause mortality, yet little is known about chronic effects of repeated, elevated exposures. Inclusion of wildfire smoke in air quality models for health effects research is important for improving accuracy of the overall models and understanding the specific and independent effects of wildfire smoke relative to the entire pollution mixture. However, the nature of smoke, including high spatial variability and the three-dimensional structure of smoke plumes, presents challenges for the accurate representation of wildfire smoke in health research applications. In this presentation, we will discuss exposure and health research applications that use explicit representations of wildfire smoke to improve exposure estimates. We used dispersion modeling of wildfire smoke to predict ground-level concentrations and support a deep learning ensemble model of PM2.5 over California for 2008-2017. Smoke emissions were modeled using satellite detections of wildfires and a database of emissions related to fire radiative energy. Emissions were dispersed using a fine-scale meteorological data set. We assessed the overall performance of the model using independent observations, and spatial and temporal patterns of wildfire smoke were assessed using visual satellite imagery of smoke and correlations with ground-based monitoring, respectively. Our results show that the deep learning model framework, with the inclusion of smoke dispersion surfaces in model inputs, produces accurate predictions of PM2.5 concentrations in wildfire smoke conditions. This work highlights the importance of incorporating wildfire smoke data sources into exposure assessments in the American West, and it indicates new directions for use of wildfire smoke data in health research.

Keyword:particulate matter (PM), spatial, other (specify below), wildfire smoke

1054558

Impact of Hurricane Harvey on Personal Chemical Exposure.

S. Samon[1], D. Rohlman[1], L. Tidwell[1], P. Hoffman[1], A. Oluyomi[2], C. Walker[2], W. Hamilton[2], G. Armstrong[3], M. Bondy[3], K. Anderson[1]; [1]Oregon State University, [2]Baylor College of Medicine, [3]Stanford University

Abstract: Over 200,000 homes were damaged or destroyed when Houston, TX experienced extreme rainfall and flooding from Hurricane Harvey. Importantly, 13 Superfund sites and several chemical/petroleum facilities were involved in unplanned chemical releases into the environment due to facility shutdowns and infrastructure damage. As clean-up efforts began communities raised questions regarding the human health impact of possible increased chemical exposure resulting from the hurricane and subsequent flooding. A multi-institution team was formed to deploy personal sampling devices in the form of silicone wristbands to a longitudinal cohort of individuals (n=99) immediately after the hurricane and again one year later. The one-year post-hurricane timepoint served as an estimated baseline chemical exposure for the Houston area. Using gas chromatography-mass spectroscopy, we analyzed each wristband for 1,530 chemicals which includes chemicals from multiple chemical categories including polycyclic aromatic hydrocarbons (PAH), dioxins & furans, pesticides, polychlorinated biphenyl's (PCBs), and brominated/oregano-phosphate flame retardants. The total detections of chemicals from the wristbands from the Hurricane Harvey study were

further compared to other wristband studies conducted by the Food Safety and Environmental Stewardship (FSES) laboratory within the United States in non-disaster scenarios using the same analytical method. In doing so we were able to identify chemicals/chemical categories that had hurricane-driven exposure and Houston-driven exposure. The mean chemicals detected/wristband was higher in both the post-flood and estimated baseline sampling periods in Houston, TX than any other comparable study. Additionally, pesticides were noted as a chemical class with Houston-driven exposure since exposure frequencies were higher at both Houston, TX than in comparable studies. PAHs had a hurricane-driven exposure since detection frequencies were higher only at the post-flood time point. When comparing across the two-time points in Houston, TX 14 of the 23 chemicals detected in 70% of the wristbands had higher concentrations post-flood, and only two had higher concentrations at the estimated baseline. When evaluating all chemicals detected at both times points it was found that PAHs and flame retardants were more likely to be found at higher concentrations post-flood, and pesticides were more likely to be found at higher concentrations at the estimated baseline.

Keyword:environmental health, longitudinal metrics, other (specify below), Disaster research

1002079
Introduction
R. Kwok; NIEHS

Abstract: Introduction to the session and speakers.

1002079
1. NIH DR2: Facilitating Harmonization of COVID-19 Research Through the Availability of Research Tools and Common Measures
A. Miller; NIEHS

Abstract: The NIH Disaster Research Response (DR2) program was created to better position research in the midst of disaster response scenarios. With the recent COVID-19 pandemic, the DR2 program served as a central repository for new instruments, protocols and tools that were developed specifically to address this disaster. The efforts of the NIH DR2 Program, which provides a suite of resources, including data collection tools, research protocols, institutional review board guidance, and training materials will help improve the timeliness, quality, and value of future disaster-related data collection and research studies.

1002079
NIEHS Time Sensitive Support for Understanding the Impact of Environmental Exposures on Coronavirus Disease 2019 (COVID-19)
B. Joubert; NIEHS

Abstract: In response to the COVID-19 pandemic, NIH launched a series of notices of special interest (NOSIs) to enable critical research. This included the NIEHS NOSI NOT-ES-20-020 addressing the impact of environmental exposures on COVID-19 and its causative agent, the severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). Relevant applications examined the role of environmental exposures in pathogenicity, transmission, individual susceptibility, or prevention and intervention strategies. This presentation will highlight

NIEHS supported projects addressing COVID-19 including research in indigenous populations with high levels of arsenic exposure, PFAS-exposed firefighters, statistical methods development, the external exposome, racial/ethnic disparities, and related research.

1002079
The NIEHS DR2 Network: Addressing COVID-19 Environmental Health Issues Through A Multidisciplinary, Multi-Institution Academic Community of Practice.
E. Haynes; University of Kentucky

Abstract: The DR2 Network was established to collaboratively advance the field of disaster research, by promoting the coordinated, ethical, and timely collection, analysis, and dissemination of environmental health research following a disaster or other extreme events to help support response, recovery, and future preparedness of impacted communities. With the need for rapid dissemination of COVID-19 research, the NIEHS DR2 Network organized to focus on the compounding environmental health crises presented by COVID-19. These include the state of the science on: routes of transmission and exposure mitigation; mental health impacts on workers; addressing COVID-19 challenges with community partners; and environmental justice.

1002079
Killing the COVID with Light Ions and Chemical Methods; What's best for your Bus
B. Buckley; Rutgers University

Abstract:A review of multiple methods for disinfection deactivation, the most effective means for keeping the bus safe for the riders of NJ Transit in the age of COVID . Covering all the current and "future" commercial methods for COVID mitigation and their mechanisms of action. The presentation will also discuss the various testing protocols for COVID and its surrogates in environmental matrices

1002079
How existing technologies and capabilities were adapted to deal with COVID mitigation strategies
B. Buckley; Rutgers University

Abstract:TBD

1001470
Pulling together multi-institutional/interdisciplinary team.
A. Oluyomi; Baylor College of Medicine

Abstract: This topic will cover matters related to how institutions could establish multi-institutional disaster study protocols that enable researchers to launch studies that span large geographic areas immediately after disasters strike. Other relevant issues will address the ease of establishing IRB protocols across institutions as well as best practices for developing informed consent that facilitate longitudinal follow-up. Another issue has to do with access to established instruments and how to encourage/facilitate their use.

1001470

Community engagement and translation of results.
D. Rohlman; Oregon Sate University

Abstract: Topic will cover matters related to best practices for working with the stakeholders that are physically located in the disaster-affected area. First, discuss issues specific to any groups that are expected to participate in a disaster research study; address issues related to recruitment/enrollment before the study and issues related to sharing research findings. Second, discuss issues related to any roles a research team or the research community in a specific area might play in terms of how the public at large (not just those enrolled in a study) responds after a disaster.

1001470
Pulling together multi-institutional/interdisciplinary team.
M. Bondy; Stanford University

Abstract: This topic will cover matters related to how institutions could establish multi-institutional disaster study protocols that enable researchers to launch studies that span large geographic areas immediately after disasters strike. Other relevant issues will address the ease of establishing IRB protocols across institutions as well as best practices for developing informed consent that facilitate longitudinal follow-up. Another issue has to do with access to established instruments and how to encourage/facilitate their use.

1001470
Going beyond questionnaire data.
J. Petrosino; Baylor College of Medicine

Abstract: Topic will cover matters related to best practices for obtaining individual biomarkers and collecting environmental samples, especially when studies are happening during the disaster or immediately after a disaster has occurred. Other relevant issues are about deciding on what types/categories of biomarker data or environmental samples should be collected based on the type of disaster. Also, discussions about best practices for handling any results from the analysis of these samples (e.g., bioethics).

1001470
Going beyond questionnaire data.
K. Anderson; Oregon Sate University

Abstract: Topic will cover matters related to best practices for obtaining individual biomarkers and collecting environmental samples, especially when studies are happening during the disaster or immediately after a disaster has occurred. Other relevant issues are about deciding on what types/categories of biomarker data or environmental samples should be collected based on the type of disaster. Also, discussions about best practices for handling any results from the analysis of these samples (e.g., bioethics).

1001470
Pulling together multi-institutional/interdisciplinary team.
W. Oluyomi; Baylor College of Medicne

Abstract: This topic will cover matters related to how institutions could establish multi-institutional disaster study protocols that enable researchers to launch studies that span large geographic areas immediately after disasters strike. Other relevant issues will address the ease of establishing IRB protocols across institutions as well as best practices for developing informed consent that facilitate longitudinal follow-up. Another issue has to do with access to established instruments and how to encourage/facilitate their use.

1001470
Going beyond questionnaire data.
C. Walker; Baylor College of Medicine

Abstract: Topic will cover matters related to best practices for obtaining individual biomarkers and collecting environmental samples, especially when studies are happening during the disaster or immediately after a disaster has occurred. Other relevant issues are about deciding on what types/categories of biomarker data or environmental samples should be collected based on the type of disaster. Also, discussions about best practices for handling any results from the analysis of these samples (e.g., bioethics).

1001470
Community engagement and translation of results.
E. Symanski; Baylor College of Medicine

Abstract: Topic will cover matters related to best practices for working with the stakeholders that are physically located in the disaster-affected area. First, discuss issues specific to any groups that are expected to participate in a disaster research study; address issues related to recruitment/enrollment before the study and issues related to sharing research findings. Second, discuss issues related to any roles a research team or the research community in a specific area might play in terms of how the public at large (not just those enrolled in a study) responds after a disaster.

1001470
Going beyond questionnaire data.
k. Hoffman; Baylor College of Medicine

Abstract: Topic will cover matters related to best practices for obtaining individual biomarkers and collecting environmental samples, especially when studies are happening during the disaster or immediately after a disaster has occurred. Other relevant issues are about deciding on what types/categories of biomarker data or environmental samples should be collected based on the type of disaster. Also, discussions about best practices for handling any results from the analysis of these samples (e.g., bioethics).

EMERGING ENVIRONMENTAL EXPOSURES

1054694
Estimating airborne exposures and urinary biomarkers of plastic trash burning among adolescent girls in rural Guatemala

K. Kearns[1], D. Boyd Barr[2], G. Lee[2], J. McCracken[1], E. Mollinedo[1], L. Naeher[1], P. Panuwet[2], E. Saikawa[2], L. Thompson[2]; [1]University of Georgia, [2]Emory University

Abstract: In Guatemala, 54% of the total population and 86% of the rural population uses wood-burning stoves for cooking and heating. This household air pollution (HAP) is comprised of harmful pollutants including fine particulate matter (PM2.5) and black carbon (BC). A related issue in rural areas like Jalapa, Guatemala is that municipal sanitation services are generally nonexistent. As a result, plastic waste accumulates until it is ultimately tossed onto public land, buried, or burned in or near homes. For this pilot study, we leveraged the randomized design of the Household Air Pollution Intervention Network (HAPIN) trial, a multi-country cookstove study investigating HAP exposure in pregnant women and children in four countries in the Global South. A population not investigated in the main HAPIN study is adolescent girls, who often help with cooking activities. We recruited 60 adolescent girls (30 per study arm) ages 13-17 years from HAPIN-Guatemala households to assess exposures to HAP including plastic waste incineration. We estimated exposures to PM2.5, BC, alkylphenols (Bisphenol A, "BPA"; Bisphenol F, "BPF"), and 9 phthalate metabolites. Participants were asked to wear an air sampling monitor for 24 h to measure PM2.5 and BC. Area monitors were placed in a subset (37%) of participants' kitchens to measure real-time BC concentrations. A questionnaire was administered to determine diet and use of personal care products and cosmetics, sources of phenols and phthalates. When we went to pick up equipment on Day 2, we collected urine samples to estimate biomarkers of exposure to BPA, BPF, and phthalates. Since HAPIN investigators are blinded to study arm until the study ends, here we present pooled analyses from this pilot study. Forty-four air filters were analyzed for PM2.5 and BC concentrations. The average personal PM2.5 and BC concentrations were 110.3 μg/m3 (range : 3.000-999.1) and 12.62 μg/m3 (range: 0.705-146.5) respectively, and the average kitchen BC concentration was 8.851 μg/m3 (range: 0.468-32.37). BPF was not detected in 98% of participants but BPA was detected in 74%. All 9 phthalate metabolites had >87% of samples above LOD with most analytes having 100% detectability. This pilot study is an important first step in characterizing exposures to HAP including domestic plastic burning, and it paves the way for future studies to continue exploring this exposure response relationship in adolescent girls.

Keyword:hazardous air pollutant (HAP), fine particlate matter, biomarkers

1054706

Applying Upper-room UVGI to Reduce Bioaerosol Exposure in Indoor Environment

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Abstract: Since the outbreak of COV-ID 2019, people have been searching for effective interventions to reduce the exposure risk, especially in indoor environments. Upper-room Ultraviolet Germicidal Irradiance (UVGI) has been shown to reduce the exposure level of bioaerosols. However, there is a lack of evidence from results in actual buildings since most studies on UVGI in recent decades were in well-controlled chambers. Our study was carried out in an American elementary school in the Midwest. The elementary school is a densely

occupied environment, along with upper-room ultraviolet germicidal irradiation (UVGI) devices installed in the selected classroom. Students from two classrooms with similar dimensions were separated into two groups 1) UVGI classroom and 2) non-UVGI control classroom. Firstly, the traditional two-stage Tisch culturable impactors were utilized to collect airborne culturable bacteria and fungi monthly during both the unoccupied period and close-to-occupied periods. Second, the requirement to continuously collect bioaerosol samples using shorter response times has called for the use of real-time detection. The decreased cost of this technology makes it available for a wider application than military use and makes it accessible to pharmaceutical and academic research. In this case study, two real-time bioaerosol monitors (RBMs) were used in the measurements. Fluorescent bioaerosol counts (FBCs) were monitored on 20 visiting days over a four-month period. For the airborne culturable fine and total bacteria levels (1-8 μm), the result of the analysis shows significantly lower in the UVGI classroom than those of the control classroom using Procedure B (p-values <0.05). For the FBC exposures, the UVGI classroom showed significantly lower concentrations of fine size (<3 μm) and total FBCs than the control classroom during 13 of the 20 visiting days. The exposure level of FBCs vastly increased when the classrooms were occupied comparing to unoccupied periods in both the UVGI and non-UV classrooms. This case study indicates that upper-room UVGI could be effective in reducing indoor bioaerosol exposure in highly occupied indoor environments. And both real-time detecting technology and traditional cultural method have conducted the same conclusion. The result also provides evidence for applying upper-room UVGI during occupied could lower the exposure risk of smaller size bioaerosols like COV-ID 2019 in the indoor environment.

Keyword:aerosol, built/indoor environment, other (specify below), UVGI

1093803

Coordinated Federal Effort to Address Emerging Contaminants' Research Gaps: 2021 Update

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Abstract: Emerging contaminants, or contaminants of emerging concern (CECs), are newly identified or re-emerging manufactured or naturally occurring physical, chemical, biological, or radiological materials that may be harmful to humans under certain exposure scenarios and do not currently have an applicable regulatory health standard. Relevant research suggests that human exposure to some CECs may result in public health effects but a lack of in-depth research on complex exposure and related health effects has hindered decision-making from the Federal to the local level. In 2018, in response to a Congressional request, the U.S. Office of Science and Technology Policy (OSTP) under the auspices of the National Science and Technology Council (NSTC) established the 'Contaminants of Emerging Concern Research and Development Task Force' (TF) to develop a coordinated cross-agency plan to address critical research gaps in addressing risks from the presence of CECs in drinking water. The TF produced the 2018 Plan for Addressing Critical Research Gaps Related to Emerging Contaminants in Drinking Water which identified critical research gaps in the areas of contaminant identification, exposure characterization, and human health impacts. As a follow

up on this pressing issue, the FY 2020 National Defense Authorization Act (NDAA) mandated requirements for federal coordination on research associated with CECs in drinking water through the formation of an Interagency Work Group (IWG). The IWG's main charge is to coordinate federal activities to identify and analyze the public health effects of drinking water contaminants of emerging concern. Also, in response to requirements in the 2020 NDAA, OSTP is drafting the National Emerging Contaminants Research Initiative (NECRI). The NECRI builds on the 2018 CEC cross-agency plan, and OSTP has partnered with the CEC IWG to obtain technical advice from the agencies. The NECRI goals are designed to meet the NDAA request to improve the identification, analysis, monitoring, and treatment methods for CECs. The presentation will provide a status update of these activities, including current areas of emphasis in exposure characterization, human health and environment effects, risk characterization, risk mitigation, and risk communications and includes consideration of environmental justice and climate change. The views expressed are those of the author and do not necessarily reflect the views or policies of the contributing federal offices.

Keyword:cumulative exposure, risk assessment, public health, Drinking water; human heath and environmental effects; risk mitigation

1054623

Metal concentrations of e-cigarette liquid and aerosol samples: a comparison by generation and popular brands.

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Abstract: Background: Toxic metal concentrations have been detected in the aerosol of electronic cigarettes (e-cigarettes); however, metal concentrations by device type, including disposable and non-disposable PODs (i.e. JUUL), have not been described. We investigated metal transfer from e-liquid to aerosol, and compared among different device generations and POD brands Methods: We sampled 109 MOD devices (MODs), nine non-disposable POD devices including Juul, and 23 disposable POD devices (d-PODs). Samples from the refilling dispenser/cartridge, aerosol, and remaining e-liquid in the tank (MODs only) were obtained. We collected aerosol from several POD devices: 4 non-disposable brands (Bo, PHIX, Suorin, JUUL) and 3 disposable brands (Zpod, Bidi, Stig). Aerosol was collected via droplet deposition in a series of conical pipette tips. Metals were measured using ICP-MS, reported as mass fractions (μg/kg) in liquids, and log-transformed for statistical analysis. Results: The median (IQR) concentrations (μg/kg) measured in the aerosol of MOD devices were 62.3 (8.00, 309) for Ni, 13.1 (3.74, 41.4) for Cr, 9.99 (2.70, 34.7) for Pb, 2.81 (0.90, 9.50) for Mn; in aerosol of POD devices we found 42.0 (27.0, 421) for Ni, 10.3 (8.40, 13.2) for Cr, 4.40 (2.75, 217) for Pb, 2.30 (1.45, 3.00) for Mn. PODs had lower mean concentrations (50%) of Ni, Cr, Pb, Mn in aerosol compared to the mean concentrations in the dispenser (p-values <0.005). MODs, however, had 90% higher mean concentrations in the aerosol for all metals compared to the dispenser, and 375% higher in the tank compared to the aerosol (p-values <0.001). Metal concentrations measured in the aerosol were comparable across device

generations. Among the non-disposable PODs, PHIX had the highest median (IQR) concentrations (μg/kg) of Cr, Mn, Ni, As, Sn, and Pb (all p-values <0.05). BO generated the highest Cu concentrations (p <0.001). JUUL generated the highest Co concentrations (p <0.001). Conclusion: E-cigarettes generate comparable metal aerosol concentrations across device generations. Within non-disposable PODs, metal concentrations in varied across the different brands. Most metal concentrations were highest in PHIX, with Pb being 5 orders of magnitude higher than the lowest (JUUL). Cobalt from JUUL was one order of magnitude higher, while Cu from BO was 5 orders of magnitude higher than the other 3 brands. These results demonstrate that all e-cigarettes are a potential source of exposure to toxic metals.

Keyword:environmental tobacco smoke (ETS), metals, other (specify below), Electronic cigarettes

1054583

Predicting smoke exposure tradeoffs among forest restoration scenarios in the central Sierra Nevada, California

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Abstract: Large wildfires are becoming more frequent and severe across the western United States, caused in part by climate change and decades of fire exclusion practices. Wildfires emit substantial quantities of air pollutants, in addition to the immediate threat to human life and property, which can lead to adverse health outcomes in surrounding communities. Forest managers are seeking to reduce high-severity fire risk and restore forest health through the use of prescribed burning (PB), among other fuel reduction strategies. While PB can mitigate the risk of high-severity fires, it still may be an important source of air pollution exposure in communities surrounding the treatment areas. The objective of this study is to explore this tradeoff by quantifying the wild and PB smoke exposure impacts of six forest health restoration scenarios proposed for the Tahoe Central Sierra Initiative (TCSI), a 2.4 million acre landscape in the Central Sierra region of California. The TSCI is made up of seven management zones, including private industrial and non-industrial land, defense zones, threat zones, general forest, roadless areas, and wilderness areas. Each management scenario varies in the extent and pace of thinning and PB applied annually to each zone. In the lowest-level management scenarios, only private lands and defense zones are treated using only mechanical fuel treatments. PB is introduced in the middle-tier scenarios, applied modestly in general forest zones and roadless zones, and maximally in the wilderness zones. In the highest-level management scenarios, PB is introduced in threat zones, and is increased in the general forest and roadless zones. For each scenario studied, we first estimate daily fine particulate matter (PM2.5) emissions using the LANDIS-II forest landscape model. Next, using the Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT), we estimate PM2.5 concentrations and exposures in downwind communities in central California. We compare the magnitude and spatiotemporal distribution of PM2.5 levels across scenarios. These estimates will enhance our understanding of how forest restoration

practices, intended to mitigate long term wildfire risk, may impact population-level air pollution exposures and how those exposures are distributed over time and space. These insights could contribute to more holistic land management decision-making that aims to promote long-term forest resilience while also prioritizing public health.

Keyword:air pollution, geospatial analysis/GIS, other (specify below), wildfire

1054586

Assessment of potential dermal absorption of perfluoroalkyl substances from water

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Abstract: Per- and Polyfluoroalkyl substances (PFAS) have many industrial uses. Due to widespread use, high water solubility and resistance to degradation, they are now widely disseminated in surface and groundwaters and detected in drinking water. Manufactured PFAS include compounds having various polar headgroups including carboxylic acid, sulfonic acid, and sulfonamide. The tendency to dissociate varies substantially among these forms as evidenced by wide-ranging acid dissociation constants (pKas). Estimation of human dose by dermal absorption of PFAS is currently difficult. Very limited in vitro experimental investigations of dermal absorption using heat separated human epidermis have been conducted, primarily with perfluorooctanoic acid (PFOA). Results of the PFOA experiments are consistent with the hypothesis that dermal absorption of the neutral acid [HA] dominates dermal absorption in human skin. This is important because some PFAS, such as those with a sulfonamide headgroup, have relatively high pKas and would be more likely to be encountered as the undissociated acid at near neutral pH. Apparent permeability coefficients extractable from the in vitro human epidermis experiments permit an initial evaluation of the applicability of traditional methods for skin permeability coefficient estimation, such as the modified Potts-Guy method applied in USEPA's Risk Assessment Guidance for Superfund (RAGS) Part E. For PFOA, correspondence is dependent upon selection of pKa—and theoretical/QSAR estimates of that parameter deviate substantially from experimental estimates. Additional insights can be gained from more recent published experiments in which artificially created, ultra-thin solid supported lipid membranes (SSLM) have been challenged with a broader range of PFAS. Results of new, previously unpublished permeation experiments using silicon rubber membranes and a homologous series of PFCAs (PFBA through PFNA) are reported here. Results from these experiments cannot be expected to correspond directly to results or predictions for human skin, but do provide insight into the effect of chain length on membrane permeation.

Keyword:PFAS, PFOA, water, dermal

1054612

Ultra-Sensitive SLE-LC-MS/MS Method Optimization and Validation for Nicotine Metabolites in Human Serum

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Abstract: Cigarette smoking remains a leading cause of preventable disease and premature death of the United States and other countries. Its active ingredient nicotine has long been recognized correlating to lung cancer. Cotinine (COT) and trans-3'-hydroxycotinine (HC) are the primary metabolites of nicotine. Because their concentrations in body fluids are greater and their eliminating half-lives are longer than nicotine, these two metabolites are generally preferred over nicotine as biomarkers of tobacco smoke exposure and are often used for biomonitoring purpose in general population study. A bioanalytical method for the measurement of COT and HC in human serum has been developed and validated by CDC (Method #2017). The CDC method has been used for large-scale biomonitoring study such as the National health and Nutrition Examination Survey (NHANES). However, due to the requirement of extensive linearity and sensitivity to cover a wide range of general population as well as two very distinct exposure groups (smokers and non-smokers), the method should be further improved for achieving higher sensitivity and wide range of linearity. The Environmental and Chemical Laboratory Services (ECLS) within the New Jersey Department of Health (NJDOH) evaluated the reference CDC, and further optimized and validated for the NJ Health and Nutrition Examination Survey (NJHANES) which is the NJ's first population-based surveillance study, including tobacco smoke exposure in NJ population. The ECLS lab has optimized the supportive liquid extraction (SLE) sample preparation procedure, resulting in greater improvements in COT and HC recovery, exceeding 95%, than the recovery from the reference CDC method. In addition, the detection limit of 0.02ppb or lower was also achieved for both analytes by minimizing the troublesome background noises. The testing method will be further validated and the complete validation results, along with optimization process, will be presented at the meeting.

Keyword:biomonitoring, analytical methods, public health

1054681

Carbon Monoxide Levels in a Semi-Industrial Area of Lagos State, Nigeria

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Abstract: Air pollution remains a public health issue in developing countries owing to the release of pollutant gases and particles driven mostly through anthropogenic activities. Carbon monoxide (CO) is of particular interest due to its toxicity and potential for outdoor exposure. This preliminary assessment determined the ambient levels of CO and corresponding air quality index (AQI) in Surulere industrial area of Lagos state, Nigeria. Surulere industrial area is one of the industrial locations in Lagos with a mix of both industries and residential buildings. 8-hour CO measurements were taken at 1 hour intervals at three sampling locations in the study area using MultiRAE gas detector. Results show that CO levels ranged from 0 – 17pm across the three sampling locations with higher concentrations recorded in the afternoon (0 – 17 ppm) as compared to morning (0 – 12 ppm). AQI exceeded satisfactory levels at a maximum AQI of 211. It is evident that there are potentials for "very unhealthy" AQI in the study area which has implications on the health of workers and residents. Exposure assessment and routine air quality monitoring are key to

determining the risks posed by CO and would help in proffering evidence-based interventions that ensure CO does not exceed permissible limits.

Keyword:air quality, air pollution, other (specify below), Air quality index, Monitoring,

1054662

The Indoor PFAS Assessment (IPA) Campaign: Preliminary Results

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Abstract: Per- and polyfluoroalkyl substances (PFAS) are a diverse group of chemicals that includes over 9,000 different compounds. Because of their water- and stain-resistant and non-stick properties, PFAS are widely used in consumer products. Not surprisingly, PFAS have been found in indoor air and dust, and concentrations tend to be higher indoors than outdoors. However, the fate of PFAS in indoor environments has not been well assessed. The Indoor PFAS Assessment (IPA) Campaign aims at measuring a broad range of PFAS in single-family homes. Samples of indoor air, airborne particles, settled dust, clothing, tap water, heating and air conditioning (HAC) condensate, and surface films will be collected in 10 homes over the course of 6-9 months. Temperature, relative humidity, and HAC operation will be monitored. Samples will be analyzed for individual PFAS, total organic fluorine, organic and elemental carbon, total water-soluble organic carbon, and major ions that regulate water uptake and pH. Particle mass and CO2 concentrations will also be measured. The results from the analyses, in combination with qualitative data from home surveys and activity checklists, will be used to characterize each home with respect to its PFAS chemistry and to assess factors that may influence PFAS transport and human exposure. Here, preliminary results obtained with different PFAS sampling strategies, mainly of air and airborne particles, are presented and their implications for human exposure are discussed. Altogether, the different types of samples will allow for a comprehensive understanding of PFAS partitioning among indoor compartments and relevant exposure pathways.

Keyword:built/indoor environment, PFAS, sampling methods

1054663

A database of pooled samples to assess age, gender and time trends of human exposure to PFAS and multiple chemicals

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Abstract: Biomonitoring plays an important role in chemical exposure and risk assessment. Pooling several biological specimens from multiple individuals into a single sample enables the identification of exposure trends and susceptible populations in a cost-effective manner, especially for children younger than five with limited extractable serum. Studies analyzing pooled samples have been conducted in Australia for multiple classes of chemicals, but without a systematic data repository that would enable analyses of age and time trends. This

study therefore aims at creating a consistent database of Human Biomonitoring Measurements (HBM) to systematically analyse age, gender and time trends across multiple chemical classes. For pooled blood samples, serum measurements were gathered for BFRs, PCBs, dioxins and furans, Organochlorine pesticides, Polychlorinated Naphthalene, and PFAS from 2002-2017 in Queensland, Australia. For PFAS, measurements are available for seven collection periods for 15822 samples combined into 206 pools with specific data for young age groups lower than 5 years old. Using quadratic regression models to study age and time trends, we provide a metric and criteria to identify chemicals with elevated and ongoing exposures in children and compare these with US trends. Over the last 15 years, PFAS concentrations have been decreasing by a factor 5 for PFOA and PFOS, by a factor 2 for PFHxS and peaked in 2009 for PFNA before decreasing in the last decade. Substance-specific differences in biomarker levels by age have increased, with stronger decrease in younger children for PFOS and PFHxS, but lower decrease and highest concentrations in younger children for PFNA and PFOA. Concentrations are equal in males and female before puberty and after menopause, whereas PFHxS, PFOS, and PFOA concentrations are reduced by up to a factor 2 for middle age women due to menstrual blood losses. The results emphasize the importance of studying the rapidly changing and substance specific exposure trends in emerging chemicals classes. Compared to US data, regression based trends for age and age2 highlights the importance and ability of pooled sample to consider concentrations in 5 years old children and younger that show the highest biomarker levels for several PFAS and most BFRs. This study shows the interest of a systematic analysis of chemical concentrations in pooled samples and the interest of analyzing results across chemical classes.

Keyword:biomonitoring, children, PFAS

1054650

Socioeconomic disparities in exposures to unregulated industrial drinking water contaminants

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Abstract: Communities of color and low-income communities often face disproportionately high burdens of exposure to pollution and racial disparities persist even after accounting for differences in income. Previous studies investigating links between drinking water quality and environmental justice have focused on regulated contaminants, for which there are enforceable standards and routine monitoring. Our current study evaluated associations between exposure to unregulated industrial drinking water contaminants and the demographics of communities served by public water supplies (PWSs). Data for four unregulated contaminants (1,4-dioxane, 1,1-dichloroethane, HCFC-22, and PFAS) associated with industrial activities were gathered from U.S. EPA's Third Unregulated Contaminant Monitoring Rule (UCMR3). Between 2013 and 2015, 4,815 PWSs in the 50 U.S. states and Washington DC, serving 284 million people, reported concentration data for at least one of these four target contaminants. We compiled county-level demographic information from the U.S. Census Bureau for counties served by a PWS included in UCMR3. We accounted for the presence of potential sources of target contaminants by compiling county-level data on U.S. EPA Toxic Release Inventory reporting and other potential sources such as wastewater

treatment plants, airports, and fire-training areas. Our analysis consistently showed that PWSs serving counties with higher proportions of Hispanic residents and more urban households are more likely to have at least 1 target contaminant detected and are more likely to exceed a federal guideline for PFOA/PFOS or 1,4-dioxane, even after accounting for PWS characteristics and presence of potential sources. We also found that an increase in the presence of UCMR chemicals (increasing number of target contaminants detected; target contaminant concentration was above a health guideline) was associated with an increase in percent Hispanic residents. We did not find consistent associations between detection of UCMR3 contaminants and proportion of Black residents or proportion of residents considered deprived (according to the Census Bureau's Multidimensional Deprivation Index). Our findings are consistent with other studies that have investigated associations with regulated drinking water contaminants and environmental justice indicators and provide new insight into the extent of socioeconomic disparities in exposures to drinking water contaminants.

Keyword:environmental justice, water, cumulative exposure

1054653

Trends in chemical exposures in the Canadian population: Biomonitoring data from the Canadian Health Measures Survey 2007–2017

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Abstract: Background:The National Biomonitoring Program of Health Canada has generated ten years of data on chemical exposures in the Canadian population through the Canadian Health Measures Survey (CHMS). These nationally representative biomonitoring data are used as a reference for baseline chemical concentrations in the general population and for comparison with vulnerable subpopulations. Here we sought to evaluate trends in chemical exposures by quantifying changes in chemical concentrations measured in the Canadian population. Method: We identified 44 biomarkers measured as part of the Canadian Health Measures Survey (CHMS) that were eligible for trend analysis. These biomarkers were measured in blood or urine over at least three cycles (six years) and had sufficient detection rates (over 50%) in the Canadian population. We calculated average (geometric mean) biomarker concentrations for each cycle using the survey weights provided. We then conducted analyses of variance (ANOVA) to test if biomarker concentrations differed over the cycles measured. For each statistically significant trend, we calculated the percent difference between the first cycle and the last cycle measured. Results: Of the 44 biomarkers examined, we found statistically significant trends for 25 biomarkers. Trends were decreasing for 21 biomarkers that represented diverse chemical classes, including metals and trace elements, phenols, organophosphate pesticides, perfluoroalkyl substances, and phthalates. Significant reductions in biomarker concentrations between 2007 and 2017 included di-2-ethylhexyl phthalate (DEHP; 75% decrease), perfluorooctane sulfate (PFOS; 61% decrease), perfluorooctanoic acid (PFOA; 58% decrease), bisphenol A (BPA; 32% decrease), and lead (30% decrease). Trends were increasing for 4 biomarkers that represented pyrethroid pesticides, with a 110% increase between 2007 and 2017 for 3-phenoxybenzoic acid (3-PBA). There was no evidence of significant trends for the remaining 19 biomarkers that represented arsenic, fluoride, acrylamide, volatile organic compounds, and polycyclic

aromatic hydrocarbons. Conclusions: National biomonitoring data in Canada indicate that concentrations, and therefore exposures, have decreased for many chemicals in the Canadian population. Emerging exposure to pyrethroid pesticides have been observed.

Keyword:biomonitoring, chemical prioritization, pesticides

1054560

Green Heart Louisville: Intra-urban, hyperlocal land-use regression modeling of oxides of nitrogen

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Abstract: Exposure to urban air pollution is linked to increased mortality from cardiopulmonary causes. Urban areas juxtapose large numbers of residences and workplaces with near-road environments, exacerbating traffic-related air pollution (TRAP) exposure. TRAP is the primary source of variability in intraurban air quality, but continuous regulatory monitoring stations lack the spatial resolution to detect fine-scale pollutant patterns that recent studies using long-term, resource-intensive mobile measurements have established as persistent and associated with higher risk of cardiovascular events. This work evaluates a low-cost approach to characterizing long-term, hyperlocal exposure to oxides of nitrogen (including NO2, a common surrogate for TRAP) as part of Green Heart Louisville (greenheartlouisville.com), a prospective cohort study examining linkages between urban vegetation, local air quality, and cardiovascular health. We used a fixed 60-site network of Ogawa passive samplers in a 12 km2 section of Louisville, KY, to measure two-week integrated NO2 and NOx (NO + NO2) mixing ratios nominally every two months since May 2018. Seasonal averages were 2.5-fold higher during winter than in summer. Annual average NO (calculated by difference in NOx and NO⁻2) and NO2 ranged from 4-21 ppb and 5-12 ppb, respectively. Both were elevated in near-road environments, with NO increasing 3-to-5-fold within 150 m of highways or major arterial roads and 2-to-3-fold near parking lots. We developed land-use regression models for annual average NO, NO2, and NOx using parameters of proximity (distance to nearest road type, restaurant, traffic signal), cumulative occurrence (length of roads, number of restaurants and traffic lights, all in buffers of up to 500 m in 50-m increments), and greenness (normalized difference vegetative index (NDVI)). Adjusted spatial variability explained by the models were 70% ($p<0.05$), 67% ($p<0.05$), and 75% ($p<0.01$) for NO, NO2, and NOx, respectively. Common predictors were distances to the nearest restaurant and road as well as total length of roads within 350 m. Only one greenness metric was significant: mean NDVI within 50 m was negatively associated ($p=0.02$) with NO2. We plan to use these hyperlocal models, refined with additional land cover parameters and vegetation metrics such as tree biomass and leaf area densities, to estimate residential-level exposures of the clinical study participants.

Keyword:air pollution, environmental health, other (specify below), land-use regression

1054548

Assessment on metabolic perturbations associated with maternal exposure to phthalates among pregnant African American women

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Abstract: Background: Phthalates have been linked with numerous harmful health effects. Limited data are available on the molecular mechanism underlying phthalate toxicity on human health. In this analysis, we measured urinary phthalate metabolites and conducted high-resolution metabolomics (HRM) to identify biological perturbations associated with phthalate exposures among pregnant African American (AA) women, who are disproportionately exposed to high phthalates levels. Methods: We used untargeted HRM profiling to characterize serum samples collected during early (8-14 weeks gestation) and late (24-30 weeks gestation) pregnancy from 73 participants from the Atlanta AA Maternal-Child cohort. We measured 8 urinary phthalate metabolites in early and late pregnancy, including Monoethyl phthalate (MEP), Mono-n-butyl phthalate (MBP), Mono(2-ethlyhexyl) phthalate (MEHP), and Mono (2-ethyl-5-hydroxyhexyl phthalate (MEHHP), to assess maternal exposures to phthalates. Metabolite and metabolic pathway perturbation were evaluated using an untargeted HRM workflow. Results: Geometric mean creatinine-adjusted levels of urinary MEP, MBP, MEHP, and MEHHP were 67.3, 6.6, 1.4, and 4.1 μg/g creatinine, respectively, with MEP and MEHP higher than the mean levels of Non-Hispanic blacks in the general US population (2015-2016). There were 814 and 1,435 metabolic features significantly associated with at least one phthalate metabolite during early and late pregnancy, respectively. Metabolic pathway enrichment analysis revealed perturbations in four inflammation- and oxidative stress-related pathways associated with phthalate metabolite levels during both early and late pregnancy, including glycerophospholipid, urea cycle, arginine, and tyrosine metabolism. We confirmed 10 metabolites associated with urinary phthalates, including thyroxine and thiamine, which were negatively associated with MEP, as well as tyramine and phenethylamine, which were positively associated with MEHP and MEHHP. Conclusion: Our results demonstrate that urinary phthalate levels are associated with perturbations in biological pathways connected with inflammation and oxidative stress. The findings support future hypothesis-testing investigations on potential molecular mechanisms underlying the impact of maternal phthalates exposure on adverse health outcomes.

Keyword:phthalates, metabolism, biomarkers

1054507

Spatial-temporal characteristics of air pollutant emissions from incense burning at temples in Hong Kong

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Abstract: Incense burning at temples has been widely agreed that it will aggravate the air quality and induces negative health effects. Previous research has indicated that burning incense emits a large amount of harmful gaseous and particulate pollutants such as particulate matters, volatile organic compounds, carbon monoxide, carbon dioxide, nitrogen oxide, and methane. However, burning incense at home or in temple is a traditional and common

practice for ritual or religious purpose in the Asian countries and cities. Hence, it is particularly important to investigate fine particulate matter (PM2.5), as its small size allows it to penetrate deep into the respiratory tract, leading to adverse health effects such as lung cancer and higher mortality rates. This study has empirically examine the spatial and temporal characteristics of the PM2.5 emissions from incense burnings at temples in densely populated urban areas of Hong Kong. The study integrated field measurements with a geographical information system (GIS) to determine the potential negative health effects of these particulates on local communities. The field measurements were conducted at strategic locations surrounding the selected temples at different time periods (i.e., summer, winter, and specific cultural events) to monitor the spatial and temporal variations. The ultimate goal of the study is to estimate the potential community health effects of the incense burning emissions that are trapped at street level by the urban canyon effect, which is caused by heavy traffic emissions and poor air ventilation. The preliminary results indicated all measurements exhibited similar temporal patterns of daily fluctuation throughout the measurement period for each temple, but varies seasonally. The spatial trend of the PM2.5 concentration was evident to be very high in the temple. The incense emission dissipated quickly in means of time (near the evening after the temple closed) and in means of spatial (away from the temple). The success of this study will not only collect evidence of the ambient air pollution created by incense burning at temples, but will also contribute to methodological advances in the field of environmental health and will provide support for future policies.

Keyword:fine particlate matter, geospatial analysis/GIS, environmental health

1054515

Characterizing the spread of antibiotic resistance in the environment using antibiotic-specific resistance selection potentials (RSPs)

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Abstract: Antibiotic resistance has emerged as one of the most pressing global health crises. There is increasing evidence that environmental exposure to sub-inhibitory antibiotic concentrations is sufficient to select for resistance and can contribute to the spread of resistance from environmental to clinical or urban settings. However, a consistent approach to assess and compare the ability of antibiotics to select for resistance is still missing. To address this gap, we predict an antibiotic-specific 'resistance selection potential' (RSP) based on modelled sensitivities of bacteria to selective pressure by different antibiotics. We propose an integrated approach to derive distributions of minimum selective concentrations (MSC) from readily available distributions of minimum inhibitory concentrations (MIC) and build species sensitivity distributions (SSDs) from MSC thresholds. We estimate the relative fitness level of a given resistant strain compared to its sensitive ancestor based on the calculated fold-increase in MIC. We combine these estimates with dose-response information of the sensitive strain toward selected antibiotics to derive MSC/MICs ratios for 2,961 antibiotic-species combinations. SSDs are derived by fitting a log-normal model to predicted MSC10, aggregated on a genus level. We determine a multi-species hazardous concentration for each antibiotic, at which 20% of bacterial genera would be exposed above their MSC (HC20), and

use it to estimate ‘effect factors’, reflecting an antibiotic’s selective potency. Combining effect with fate and exposure factors, we estimate comparative RSPs for 137 antibiotics. Relative fitness levels ranged from 0.5 to 0.98 and for 70% of the studied combinations, the MSC was 1-2 orders of magnitude below the MICs. Based on modelled SSDs, 70% of the antibiotics have an HC20 between 1.5 x10-3 and 6.7x10-2 mg/L. Compared with measured environmental concentrations, a hazard of selection is found for multiple antibiotics in untreated sewage, wastewater effluents, liquid manure and surface waters. HC20 and corresponding selective potencies/ RSPs can be of high relevance to antibiotic-producing companies assessing risks for resistance selection associated with their own discharges, and for policymakers seeking to prioritize antibiotics for setting emission limits or drawing recommendations on the use of certain ‘more sustainable’ antibiotics in therapeutic contexts.

Keyword:ecological exposure, pharmaceuticals, infectious disease

1054525

Addressing uncertainty in mouthing-mediated ingestion of chemicals on indoor surfaces, objects, and dust

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Abstract: In indoor environments, humans ingest chemicals present as surface residues and bound to settled particles (dust), through mouthing hands (hand-to-mouth transfer) and objects (object-to-mouth transfer). While such mouthing-mediated ingestion of chemicals has attracted long and increasing attention, it has seldom been considered in indoor fate and exposure models, leading to potential underestimation of the overall indoor exposure. Here, we introduce a novel modeling approach in support of modeling mouthing-mediated ingestion. This model explicitly considers the indoor dynamics of dust and chemicals, building on mechanistic links with physicochemical properties of chemicals, features of the indoor environment, and human activity patterns. The evaluation of this model demonstrates that it satisfactorily reproduces chemical hand loadings and exposure data reported in the literature. We then use the evaluated model to investigate the response of mouthing-mediated ingestion to chemical partitioning between the gas phase and solid phases, expressed as the octanol–air partition coefficient (KOA). Assuming a unit emission rate to the indoor environment, we find that low-volatility chemicals are more efficiently enriched in hand skin, resulting in higher mouthing-mediated ingestion than other compounds. We also use the new model to explore how the mouthing-mediated ingestion of chemicals is dependent on factors describing the indoor environment and human behavior. For instance, the model predicts that less frequent cleaning leads to a higher accumulation of dust on indoor surfaces, thereby transferring more chemicals to hands and mouth in each contact. Introducing more dust into the room, but maintaining the same cleanup frequency, increases the dustiness of indoor surfaces, which promotes the transfer of relatively volatile chemicals to hands and mouth but decreases the transfer of chemicals with low volatility. More frequent hand contact with indoor surfaces increases both the hand loading and mouthing-mediated ingestion of chemicals, but the increases are more remarkable for adults than children because the higher surface contact frequency of children “saturates” hand loadings. The new evaluated modeling approach can facilitate the prediction of mouthing-mediated ingestion for various age groups

and the model predictions can be used to aid future fate and (bio)monitoring studies focusing on indoor contamination.

Keyword:exposure models, aggregate exposure, built/indoor environment

1054402

Characterization of multiple pesticide exposure in pregnant women in Brittany, France.

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Abstract: Exposure to pesticides is a current concern and more particularly in Brittany (France), which has large agricultural areas. The objective of our work is to describe multiple pesticide exposure in a cohort of pregnant women in Brittany (France). Method: Pregnant women (n=296) from the PELAGIE mother-child cohort were selected according to the availability of a urinary sample collected in 2004. Forty compounds were selected based on agricultural practices, and analytical feasibility in a single multiresidue method specifically developed for this project. The urinary samples were analyzed by UHPLC-HRMS using both negative and positive electrospray modes, after enzymatic hydrolysis followed by solid phase extraction. Most of the women are 25-34 years old (75.7%), have a high education level (82.1%) and live in a rural area (81.8%). In urinary samples, 27 molecules were detected, corresponding to 17 pesticides and 4 chemical families (organophosphorous, pyrethroids, carbamates, and aryloxyphenoxypropionic acid derivatives). The limits of detection ranged from 0.02 µg/L to 25 µg/L. The most frequently detected compounds are the metabolites of organophosphorous and pyrethroids: frequencies of detection (FD) up to 97% for diethylphosphates and 89% for 3-phenoxybenzoic acid. Phenoxypropionic acid derivatives, chlorpyrifos, and fluazifop were detected in > 60% of samples. Prochloraz, bromoxynil, diazinon and procymidone were detected between 10 and 50%. Quizalofop-p-ethyl, cyfluthrin, azoxystrobin, and carbendazim, were detected in 4-10% of samples. FD for 6-chloronicotinic acid, carborfuan, malathion, phorate, 3-chlroaniline, chlorpyrifos-methyl, dichlorvos, and 2-phenylphenol were less than or equal to 1%. The other pesticides were not detected. Among detected pesticides, urinary concentration levels range between 0.02 µg/L for azoxystrobin until 600 µg/L for methyl-organophosphorous. Discussion: these exposures are consistent with pesticide uses at the time of collection: organophosphorous and pyrethroids insecticides were widely used both in agriculture and at home as plant protection, biocidal, and pest control products. Fluazifop-p-butyl, bromoxynil (herbicides), and prochloraz (fungicide) were widely used in agriculture to treat cereals, rapeseed, and vegetables. Our results will be compared to other French and European studies, for exposures levels and pesticide uses, performance of instruments used, and methods to determine urinary dilution.

Keyword:biomarkers, multiple stressors, environmental health

1054493

Impact of E-cigarette use behaviors and device characteristics on exposure

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Abstract: Introduction: Electronic cigarettes (e-cigarettes) rapidly evolved in the past 5 years, from “mod” devices mostly used by smokers as a risk reduction strategy, to “pod” devices marketed to youth and never smokers. Mod devices allow the users to customize the coils, batteries, tanks, temperature, voltage, and power, whereas users of pod devices can only choose flavors by removing prefilled or refillable cartridges (“pods”). Understanding e-cigarette use behaviors is essential to understand potential exposures. This study compares use behaviors between those who use e-cigarette mod devices, pod devices, and those who are dual users of e-cigarette and combustible cigarettes. Methods: We recruited 95 participants beginning in April 2019 to March 2020, belonging to Mod, Pod, smoking, dual cigarette and e-cigarette users, and non-e-cigarette/non-smokers groups. Sociodemographic characteristics, e-cigarette/tobacco use behaviors, device characteristics and preferences were collected by survey. Chi-squared tests for categorical variables, ANOVA tests for continuous variables, and linear regressions were used to assess relationships between variables and groups. Results: On average, dual users (n=14) were the oldest (35 years) and pod users (n=24) the youngest (22 years). Among pod users, 79% were students and 75% were never smokers. Mod users (n=17) reported greater mean number of puffs per day (374 +/- 587) compared to pod users at 93.5 (+/-82.5) and dual users at 132.6 (+/-125.2) puffs per day. Seconds per puff for Mod and Pod groups were similar at 3.5 and 3.7, respectively. Nicotine concentration was significantly associated with education status ($p = 0.012$) and former smoking status ($p < 0.001$). Education was significantly associated with Mod power ($p = 0.038$) and time since last coil change ($p = 0.044$). The amount of time to finish one pod was significantly associated with race ($p = 0.032$). Conclusion: Certain e-cigarette use behaviors were significantly associated with sociodemographic characteristics, providing an indication that exposures may vary between user groups. Describing patterns of e-cigarette use is critical in understanding the chronic exposure that could potentially result in long-term health effects.

Keyword:activity patterns, consumer and personal care products, health, other/general

1054468

Indoor Radon Exposure from Main Types of Built Environments in China after 2000

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Abstract: After decades of development, the indoor environment in China has changed. A systematic review was conducted from peer-reviewed scientific papers. The first stage of this systematic review is to search in major databases. There were 1479 papers on indoor radon in China from 4 online databases and they were published between 2000 and 2020. The data of indoor radon concentrations, building types, test condition, location, and the sample size was extracted from the remaining 114 references. we mainly focused on field measured data from dwellings, office buildings, and school buildings, since the exposure time of occupants is most in these three types of buildings. In addition to the data of indoor radon, we also collected the data of the test environment from the papers. Based on the sampling information from the selected papers, we selected 7 factors that potentially influence indoor radon levels and can be categorized or counted clearly. There are 5 categorical variables and 2 continuous variables, which are the type of buildings, climate regions, seasons, ventilation, decoration,

outdoor air radon, and soil radon. The mean concentrations of indoor radon for dwellings, school buildings, and office buildings are 54.6 Bq/m3, 56.1 Bq/m3, and 54.9 Bq/m3. The indoor radon concentration was related to seasons, climate regions, ventilation, decoration and other factors such as soil and outdoor air. Colder seasons, especially in severe colder areas of China, newer decorated buildings, closed windows, and doors were all associated with higher indoor radon concentrations. Variables like climate region and ventilation showed statistical significance in the correlation analysis. Regarding the increasing trend of indoor radon concentration in China during the last two decades, further study of indoor radon is necessary especially for school buildings and office buildings and will help access the environmental burden of disease in China more accurately.

Keyword:radon, built/indoor environment, GIS

1054340

Healthier Materials Interventions to Reduce Stain Repellent and Flame Retardant Chemicals in Hormonally Active Dust

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Abstract: Per- and polyfluoroalkyl substances (PFAS) and flame retardants are two classes of hormone-disrupting chemicals widely used in furniture, carpet, and other building materials. We conducted two studies about our exposures to these chemicals in indoor dust in buildings. In the first, we evaluated the hormonal bioactivities of indoor dust in human hormone cell assays and the resulting associations with chemical concentrations. We found that every single indoor dust sample (n=46) was hormonally active. The degree to which the dust extracts interfered with estrogen, androgen, thyroid hormone, or PPARg receptors was associated with the total concentrations of PFAS or flame retardants in the dust. In the second study, we evaluated the benefits of real-world “healthier” materials interventions on reducing these chemical classes in dust. “Healthier” materials included furniture and carpet that were specified as free of all types of PFAS and flame retardants. Our statistical models showed that the rooms with full “healthier” materials had 78% significantly lower total levels of PFAS in dust, 65% lower levels of organophosphates (used as flame retardants and plasticizers), and 45% lower levels of polybrominated diphenyl ether flame retardants, compared to rooms with no intervention or only a partial intervention. This result supports the need to make “healthier” materials the norm in order to reduce our exposures to hormone-disrupting chemical classes. Future interventions should address other building materials (e.g. electronics and insulation) and other chemical classes (e.g. plasticizers).

Keyword:building materials, SVOCs, PFAS

1054347

Chemical Exposures of Office Workers in the USA, UK, China, and India Using Silicone Wristbands

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Abstract: We are exposed to complex mixtures of semi-volatile organic chemicals inside buildings. Few studies have pinpointed personal exposures of office workers to chemicals in their work buildings globally. We examined external exposures of 251 workers to 99 chemicals in offices in the USA, UK, China, and India by instructing participants to wear silicone wristband samplers only while they were at work for four days. We found substantial differences in chemical exposures by country. For example, flame retardant exposures tended to be higher in the USA and UK, likely due to historic furniture flammability standards. Exposures to several pesticides may have been higher in India due to malaria control and fewer restrictions. Exposures to polycyclic aromatic hydrocarbons (PAHs) were often higher in China and India, possibly because of higher outdoor air pollution penetrating into buildings. In addition, office worker exposures to several legacy chemicals that had been banned decades ago still persisted (such as polychlorinated biphenyls and certain pesticides). Chemicals commonly used as substitutes to phased-out legacy chemicals ubiquitously exposed office workers, including novel brominated flame retardants and organophosphate esters. Finally, building materials and personal care products, not just countries, were significantly associated with certain chemicals in statistical models. In summary, we found major country differences in chemical exposures and continued exposures to legacy phased-out chemicals and their substitutes in buildings.

Keyword:SVOCs, built/indoor environment, sampling methods

1054406

Association between Urinary Phthalate Metabolites and Biomarkers of DNA Damage and Lipid Peroxidation in Pregnant Women - Tainan Birth Cohort Study (TBCS)

P. Huang, W. Chang; National Health Research Institutes

Abstract: Oxidative stress biomarkers were suggested to be intermediates link between phthalate exposure and adverse health outcomes in pregnant women. This study explored the relationship between urinary phthalate metabolites and biomarkers indicative of lipid peroxidation and oxidative and nitrosative DNA damage. Measurements from 97 Taiwanese women were taken across three trimesters. Five oxidative/nitrosative stress biomarkers - 8-hydroxy-2′-deoxyguanosine (8-OHdG), 8-nitroguanine (8-NO2Gua), 4-hydroxy-2-nonenal-mercapturic acid (HNE-MA), 8-isoprostaglandin F2α (8-isoPF2α), and malondialdehyde (MDA), and 11 phthalate metabolites were measured in urine samples. Linear regressions in each trimester and a linear mixed-model regression were fitted to estimate percent changes in oxidative/nitrosative stress biomarkers resulting from any inter-tertile increase of phthalate metabolite level and the cumulative concentration of di (2-ethylhexyl) phthalate and dibutyl phthalate. The highest urine concentrations of phthalate metabolites and the greatest number

of significant positive associations between phthalate metabolites and oxidative/nitrosative stress biomarkers were observed in the third trimester and through repeated measurements analysis, respectively. Of the biomarkers related to DNA damage, 8-OHdG (25.4% increasing for monoiso-butyl phthalate tertile increased) was more sensitive to phthalate exposure than 8-NO2Gua. Among the biomarkers of lipid peroxidation, HNE-MA (61.2% increasing for sum DEHP tertile increased) was more sensitive than 8-isoPF2α and MDA. Our results suggest an enhanced susceptibility to phthalate exposure in the third trimester. Future research is necessary to evaluate the mediating role of oxidative/nitrosative stress biomarkers in the link between phthalate exposure and adverse reproductive outcomes.

Keyword:biomarkers, phthalates, prenatal

1054439

Evaluating Exposure to Organophosphate Ester Flame Retardants via Drinking Water and the Indoor Environment

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Abstract: Organophosphate esters (OPEs) have been used for many years as flame retardants and plasticizers in consumer products and building materials. As a result, exposure to OPEs is common and metabolites of OPEs are commonly detected in urine from the general population. Previous studies have demonstrated that residential air and house dust are sources of exposure to OPEs; however, little is known about exposure through drinking water. OPEs have been detected in drinking water from China, but there is little data on OPEs in US drinking water. The goal of this study was to assess the relative amount of OPE exposure from drinking water compared to the indoor environment. Here, we recruited participants (n=38) from central North Carolina (USA) to wear a silicone wristband for five days to assess indoor exposure to OPEs. While wearing the wristband, each participant collected three samples of their drinking water and three first morning void urine samples. Online questionnaires were also completed the day before each set of water or urine samples were collected. Individuals in this study ranged from 22 to 67 years and the majority were female (69%). Drinking water samples were analyzed for 7 different OPEs. Tris (2-chloroisopropyl) phosphate (TCPP) was detected most frequently (detection frequency = 59%) and in the highest concentrations ranging from

Keyword:flame retardants, water, built/indoor environment

1054440

Exposure And Safety Estimation (EAS-E) Suite: an integrated platform to facilitate chemical assessment

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Abstract: Ecological and human health assessments are challenging because of the significant exposure data gaps for most chemicals. Exposure science is a multidisciplinary science requiring multiple stakeholder engagement with varying levels of expertise in different areas

of specialization. New Approach Methods (NAMs) for exposure estimation are rapidly advancing and there is a need to provide user-friendly access to new and existing databases, tools, and models that can be used to estimate exposure and associated risks. Multimedia fate, PBTK, bioaccumulation, and exposure models are often required for exposure assessment. The application of these types of models requires chemical information in various categories, including properties (e.g., partition coefficients, solubility), toxicokinetics (e.g., biotransformation rates), environmental degradation half-lives, use patterns, and emission rates. There is often limited time and expertise required for parameterizing and applying these tools. The Exposure And Safety Estimation (EAS-E) Suite is a free on-line platform developed to facilitate the "one-stop" application and evaluation of databases, QSARs and mass-balance models to support exposure and risk estimation for various stakeholders. EAS-E Suite is comprised of chemical information databases and QSARs to automatically parameterize various models and tools to simulate chemical fate and exposure of ecological receptors and humans. EAS-E Suite includes a model for estimating life cycle chemical mode-of-entry and emission rates; critical information required to parameterize and apply fate and exposure models. EAS-E Suite can be queried using either CAS, SMILES, or chemical name as the "user input" to obtain the input parameters for model simulations. EAS-E Suite contains >200,000 experimental and predicted physical-chemical properties for about 50,000 discrete organic chemicals including curated in vitro and in vivo toxicokinetics data. Data are provided with complementary information to aid data quality analysis and transparency. Moreover, a suite of QSAR models is available to estimate biotransformation half-lives in fish and mammals. EAS-E Suite can facilitate knowledge translation to various stakeholders on issues in exposure assessment and environmental health and help bridge the gap between evolving scientific research and assessment challenges. An overview of EAS-E Suite and case example applications are presented.

Keyword:ecological exposure, aggregate exposure, exposure models

1054428

Estimation of Total Exposure to CMIT/MIT during Children's Modelling Clay Use in Korea

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Abstract: Modelling clays were commonly used as children's toys and teaching tools. Because clays are adhesive, users may be exposed to harmful chemicals through the skin absorption, and the adhered clay may be exposed through oral route due to child's hand-to-mouth (HTM) behavior. In addition, inhalation exposure route shall be considered for volatile compounds in clay. This study was conducted to estimate exposure to 5-chloro-2-methyl-4-isothiazolin-3-one (CMIT) and 2-methyl-4-isothiazolin-3-one (MIT) through oral, inhalation, and skin absorption routes during children's modelling clay use. The purchased 65 clay products were subjected to GC-MS analysis for quantification of CMIT and MIT. Usage patterns for modelling clay were collected through national representative survey of 20,000 children participants. Total exposure assessment for CMIT and MIT was conducted through exposure algorithms for each of the three exposure routes. Of the 65 clay products, CMIT and

MIT were detected in 16 products with an average of 23.41mg/kg, and 17 products with an average of 6.01mg/kg, respectively. From the survey, 12,144(60.7%) children used clay. Use frequency was 1.24±1.90 times per week and use time was 24.24±12.78 minutes per time. Total exposures to CMIT and MIT were 237.62±401.14ng/kg-day and 25.57±46.24ng/kg-day, respectively. For CMIT and MIT, skin absorption was a dominant exposure route among the three exposure routes. The contribution of inhalation exposure was greater for CMIT than for MIT. The contribution of oral and inhalation exposures was higher in infants (0-2 years old) than in other age groups. This study estimated the total exposures to CMIT and MIT during children's clay use. The contribution of each route exposure to total exposure differ depending on the chemical. Therefore, total exposure assessment including all exposure routes is needed for accurate exposure estimation and risk management.

Keyword:SVOCs, exposure factors, other (specify below), total exposure

1054449

Urban and rural exposures to metals and essential elements in pregnant Surinamese women

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Abstract: In Suriname, South America, 20% of pregnancies end in an adverse birth outcome. While the impact of metal exposure on maternal and child health (MCH) is well-known, exposure assessments in Suriname have been limited. The study population (n=400) is a sub-cohort of the Caribbean Consortium for Research in Environmental and Occupational Health prospective longitudinal cohort study, aimed at assessing the impact of chemical and non-chemical stressors on MCH. This is the first comprehensive study to assess blood levels of metals and essential elements in pregnant Surinamese women. Of specific concern is exposure to Mercury (Hg) used for artisanal goldmining (ASGM) in Suriname's Interior, in pregnant vulnerable Indigenous and Tribal Peoples. Sector-field inductively-coupled plasma mass spectrometry was used to assess exposure to lead (Pb), Hg, selenium (Se), cadmium

(Cd), manganese (Mn) and tin (Sn) during pregnancy. Based on environmental exposures, three areas were identified: Urban, Suburban agricultural areas, and Interior goldmining areas. The Mann-Whitney test was used to examine differences among exposures in these areas. The highest median concentrations of Pb, Hg and Se (8.5 μg/dL, 12.5 μg/L, and 246.2 μg/L respectively) were found in Interior women. These were significantly higher than in the Urban and Suburban regions ($p<0.001$). The highest median concentrations of Mn and Sn were found in Suburban women (17.6 and 0.97 ug/L respectively). These were significantly higher than both Urban and Interior regions ($p<0.02$). Median levels of Pb and Hg in Interior women were higher than EPA action levels of 5 μg/dL and 5.8 ug/L respectively, and this was statistically significant for Pb (one-sample Wilcoxon signed rank test, $p<0.001$). The biomarker assessments are consistent with some expected environmental exposures in each region. ASGM likely explains the high levels of Hg in Interior women. The high levels of Mn and Sn in Suburban women may be explained by the heavy use of the Mn-containing fungicides and Sn-containing molluscicides. Environmental assessments of the Interior are ongoing to identify the possible sources of Pb. Interior women are exposed to Hg and Pb at levels of public health concern. CCREOH's research is ongoing to assess the effects of these exposures on MCH.

Keyword:environmental health, metals, prenatal

1054189

Agricultural use of 1,3-Dichloropropene and emergency department visits for asthma in California from 2013 to 2017

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Abstract: In this study, we investigate the potential association of agricultural use of 1,3-dichloropropene (1,3-D) and emergency department (ED) visits for asthma in communities in California from 2013 to 2017. No previously published studies have analyzed acute human health effects resulting from nearby soil fumigant usage. We conducted spatial analysis of the California Department of Pesticide Regulation's pesticide use report (PUR) data to select the communities for this study. PUR data is recorded with geographic locations as townships and sections, the land units of the Public Land Survey System (PLSS). We created buffers with 1-mile and 5-mile radii around sections with 1,3-D use to determine two potential exposure zones. Similar methods were also used to determine 5-mile potential exposure zones around the applications of other soil fumigants (i.e., chloropicrin, methyl isothiocyanate, and methyl bromide) and those areas were excluded from the community selections. We intersected ZIP Code Tabulation Area polygons with the fumigant exposure zones. For the 2013 -2017 period, the PUR spatial analysis resulted in two sets of study sites: 21 zip codes that had 1,3-D use within 1 mile and 51 zip codes that had 1,3-D use within 5 miles. The 1,3-D applications around respective sets of study sites were extracted for the statistical analysis. No other fumigants were used within 5 miles of these zip codes. We are now in the process of extracting the ED visit data of the selected zip codes from the California Office of Statewide Health Planning and Development databases. We will implement a case-crossover study design in which we select subjects from cases, i.e. those who visit the ED due to asthma during the exposure period of 1,3-D applications. We will use a bidirectional-symmetric approach to compare soil fumigant usage within a week prior to the ED visit for each case

with fumigant use during two control periods, both before and after ED visits. We will examine whether the association is modified by weather factors such as wind speed or direction, temperature, and relative humidity, and concomitantly present pollutants such as particulate matter and nitrogen dioxide. We will also evaluate the relationship stratified by age, race/ethnicity, and sex.

Keyword:pesticides, epidemiology, air pollution

1054079

Human biomonitoring of the fragrance chemicals 7-hydroxycitronellal, lysmeral and geraniol in urine samples from the Environmental Specimen Bank

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Abstract:7-Hydroxycitronellal (7-HC), lysmeral (also traded as lilial), and geraniol are fragrance chemicals which are frequently used in various cosmetic and hygiene products. All three chemicals are listed as contact allergens due to their skin sensitizing properties. In addition, reproductive toxicity and potentially endocrine disrupting effects are properties of concern for lysmeral according to the European Chemicals Agency (ECHA). Due to their widespread use and given the known toxicological potency, analytical methods for a human biomonitoring (HBM) were developed and validated (according to FDA guidelines) in order to assess the exposure in the general population within the frame of a collaboration between the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the German Chemical Industry Association. Therefore, human metabolism studies with a defined oral dose of the respective chemical were conducted for the identification and quantification of the major urinary metabolites by LC-MS/MS. The methods were applied to 329 24h-urine samples of young adults (20-29 years) derived from the Environmental Specimen Bank between 2000 and 2018 to assess the exposure to the aforementioned fragrance chemicals over time. This HBM campaign revealed a ubiquitous exposure to 7-HC, lysmeral and geraniol with a decreasing trend within the investigated time period for 7-HC and lysmeral. Moreover, sex-specific differences were significant for 7-HC and geraniol with higher uptake in women while women showed only a moderately higher exposure to lysmeral. In addition, the daily intakes were calculated for lysmeral and 7-HC based on the fractional urinary excretion established in previous metabolism studies and compared to health-based guidance values (derived no effect level; DNEL) for the general population. Our data suggest a low risk from the uptake of these fragrance chemicals. However, considering the ubiquitous exposure, reduction thereof is still needed. Given the limited sample size and the age span of the investigated population as well as the critical toxicological profile, especially of lysmeral, future HBM campaigns within the frame of the German Environmental Survey on adults (GerES VI) will add important data for a comprehensive risk assessment.

Keyword:biomonitoring, biomarkers, risk assessment

1054049

Examining oxidative potential of residential outdoor PM2.5 in metropolitan cities

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Abstract: Background: Exposure to poor air quality is one of the grimmest problems faced all over the world, especially in the metropolitan cities where traffic, industrial and commercial zones are highly explicit in the residential sites. To determine the toxicity due to fine particulates matter (PM2.5) in these regions, oxidative potential (OPDTT) can be utilized as one of the indicators. Objectives: The aim of the study is to examine the spatial and seasonal variation in the OP of PM2.5 between and within the metropolitan cities of India. Methods: Oxidative potential of daily collected PM2.5 in three cities in India - Mumbai, Bangalore and Delhi - from different neighborhoods representing traffic, residential and industrial (small-scale) sites was assessed using dithiothreitol (DTT) assay. Daily sampling was conducted for 14 days in two distinct seasons. The association of OP with PM chemical characteristics (BC,WSOC) is also examined. Results: Average (±SD) PM2.5 during the winter was significantly different in Bangalore (76±32µg/m3), Mumbai (121±57) and Delhi (195±71) ($p<0.05$), while no significant difference found among the neighborhoods within the cities. The corresponding OP levels were 0.1±0.1; 0.3±0.3 and 0.3±0.1 nmolmin-1m-3 respectively. There was statistically significant difference between traffic and residential/industrial sites in Mumbai whereas in Delhi, observed between traffic and residential site. OPDTT for tri-city showed high correlation with PM2.5 for Mumbai (R=0.5) which is ~2 times higher when compared with other cities. Similarly, with BC moderate to low correlation were observed for Delhi(0.21), Mumbai(0.38) and Bangalore(0.25). The water-soluble organic carbon (WSOC) was only correlated with OP for Mumbai winter samples with moderate correlation observed for industrial (0.64) and traffic sites (0.54). There was significant spatial heterogeneity in the OP for Mumbai, Delhi and Bangalore, as observed by the coefficient of divergence 0.4, 0.6, 0.33,respectively. No significant difference was found between the summer (0.2±0.1) and winter (0.3±0.2) OPDTT in Mumbai. Conclusion: Our findings suggest that the PM2.5 toxicity at residential locations vary between metropolitan cities in India but not within a city, and not in the same proportion as the PM2.5, suggesting the differential influence of source mix and PM chemical composition. Additional chemical characterization of PM to trace spatial and seasonal variation in OP is currently underway.

Keyword:particulate matter (PM), Toxic/Toxicology, other (specify below), oxidative potential

1054054

Exposed… to what? Non-targeted biomonitoring shows high environmental burden of children

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Abstract: Environmental pollution poses significant effects on human health. This is especially concerning in vulnerable populations, such as children undertaking rapid physiological changes. Unintended exposure to several chemicals has been linked to among

others adversely affect children's reproductive system, neurological system and even their mental health. When monitoring the exposure of children we usually look at predetermined compounds with known toxicity. However, by doing so we fail to see unexpected and potentially toxic new chemicals entering the environment in real-time. As a principle, non-targeted (NT) analysis aims at detecting everycompound, facilitating real-time exposure monitoring for already known and newly emerging chemicals of concern. Herein, we present results of global-scale exposure analysis of Slovenian children. As an exposure endpoint, urine of children, aged 6-9 years was collected. Samples were concentrated and purified using solid-phase extraction and analysed using ultra-high pressure liquid chromatography coupled to high-resolution mass spectrometry. Data was processed using the open source MzMine 2.53, with parameters optimized for detection of low-abundance compounds. The resulting data matrix was mined using experimental and in-silico mass spectral libraries connected to feature-based molecular networking (FBMN). Compounds were identified using Sirius-CSI:Finger-ID and CFM. We identified 77 contaminants at the identification confidence level II. The children were among others exposed to pesticides, including the restricted atrazine and amitraz. Further, we detected plasticizers, such as phthalates and bisphenols, with known endocrine disrupting potential, and compounds deriving from personal care products, such as parabens, UV-filters, surfactants, polyethylene glycols and polyethylene glycol ethers. On top of the identified biomarkers, our data shows the potential to reveal much more information about the potential exposure. In any case, the identified organic contaminants raise health concerns suggesting further science and policy actions to weaken the environmental burden to children's health.

Keyword:biomonitoring, big data, cumulative exposure

1054066

BISPHENOL A AND TRICLOSAN LEVELS IN URBAN SPANISH ADOLESCENTS FROM A NATIONAL HUMAN BIOMONITORING SURVEY

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Abstract: Human Biomonitoring (HBM) is a very useful tool to assess exposure to chemical substances in the general population. HBM considers all routes of uptake and all sources of exposure, allowing the identification of new chemical exposures, time trends, to establish reference values for the general population or to identify vulnerable groups and highly exposed populations. Therefore, HBM is a valuable support for the development of environmental and health policies. In 2016, the Spanish Ministry of Agriculture, Food and Environment co-funded together to Instituto de Salud Carlos III, the BEA study, the first nationwide HBM survey carried out in Spain to study the levels of selected environmental pollutants in adolescents living in urban areas. The BEA study involved 499 volunteers (14-16 y) of both genders, who were recruited through 20 secondary school centers from 11 big cities. Sampling was carried out from Oct. 2017 to Feb. 2018 and it included the collection of hair, urine and blood samples, and a self-administered epidemiological questionnaire.

Phenolic compounds, specifically bisphenol A (BPA) and triclosan, were selected due to their toxicological relevance. Furthermore, they are ubiquitous in the environment because of their presence in consumer products since, BPA is found as a plasticizer in polycarbonate plastics and epoxy resins and triclosan as antibacterial and fungicidal agent. Urinary levels from 499 adolescents were determined using a method based on solid-phase extraction on-line coupled liquid chromatography with tandem mass spectrometry LC-MS/MS. The geometric means (GM) for BPA, both no adjusted levels and creatinine adjusted, were 1.32 μg/L and 1.11 μg/g creatinine, with 86 % of the samples above limit of quantification (LOQ). The GM for triclosan were 1.52 μg/L and 1.29 μg/g creatinine, 99 % of the samples above LOQ. The statistical analysis did not find significant differences regarding gender for none of the compounds. In relation with geographical differences, while BPA presented a homogeneous geographical distribution, significant differences were found for triclosan ($p<0.05$), being Granada the city that presented the highest triclosan levels (GM: 3.27 μg/g creatinine). Authors thanks the schools and all the volunteer participants in BEA. The study was funded by the Spanish Ministry of Agriculture, Food and the Environment, the Instituto de Salud Carlos III (nº SEG 1321/15) and Horizon 2020 program for HBM4EU initiative (733032).

Keyword:biomonitoring, environmental health, analytical methods

1054074

Microplastics Scoping Review

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Abstract: Microplastics are plastic particles <5mm in size which may arise from either primary or secondary sources. Examples of common types of microplastics are polyvinyl chloride, polypropylene, polysulfone, and polyethylene tetraphthalate. As microplastics is a relatively new field of research, not much is known about the effects that microplastics can have on human health and the environment. To assess the current size and scope of the available research on microplastics, the NCEH/ATSDR Microplastics Working Group is conducting a scoping review, to rapidly identify the key concepts underlying a research area and the main types and sources of evidence available. The Microplastics Working Group categorized published journal articles from 1974-2020 into bins delineated to define identification, transport, exposure, and health effects. Twelve survey questions were answered, documented, and tracked. Most publications occurred after 2004. Many were about identification and transport. Few identified human exposure or health effects. This poster presentation identifies a representative percentage of some of the published works.

Keyword:ecological exposure, cumulative environmental effects, other (specify below), microplastics

1053720

Exposure Model Peer Review -- Exploring Key Attributes to Elucidate Best Practices

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Abstract: The extent and rigor of peer review that a model undergoes during and after development helps inform users' and managers' confidence level in model predictions. A process for dimensioning the breadth and depth of peer review of exposure models has been developed with the input from a panel of exposure modeling experts. This included consideration of tiers and types of models (e.g., screening, deterministic, probabilistic, etc.). The experts recommend specific criteria be considered when evaluating the degree to which a model has been peer reviewed, including quality of documentation, and model peer review process (e.g., internal review with a regulatory agency by subject matter experts, expert review reports, formal Scientific Advisory Panels, journal peer review, etc.). In addition, because the determination of the confidence level for an exposure model's predictions is related to the degree of evaluation that the model has undergone, irrespective of peer review, the experts recommended the approach include judging the degree of model rigor using a set of specific criteria: (1) nature and quality of input data, (2) model verification, (3) model corroboration, and (4) model evaluation. Other key areas considered by the experts included recommendations for addressing model uncertainty and sensitivity, defining the model domain of applicability, and flags for when a model is used outside its domain of applicability. The findings of this expert engagement will help developers as well as users of exposure models have greater confidence in their application and yield greater transparency in the evaluation and peer review of exposure models.

Keyword:exposure models, pesticides, chemical prioritization, Peer Review

1053791

Characterization of size-fractionated aerosols from electronic cigarette with pod cartridge and modifiable (Pod-Mods) system

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Abstract: Electronic cigarette (E-cigarette) is used to deliver nicotine, cannabis, flavorings, and other substances. In 2018, more than 3 million high school students (20.8%) and 0.57 million middle school students (4.9%) reported as current users of e-cigarette in the United States. While the particle count size distribution of e-cigarette aerosols is well characterized, the size-fractionated mass distributions of e-cigarette aerosols and the human airway deposition patterns are not fully assessed despite potential adverse health effects from exposure to e-cigarette aerosols. In this study, we purchased six flavored e-cigarettes at an e-cigarette shop: three flavors without nicotine (strawberry, mango, and grapefruit) and three flavors with nicotine (menthol, chocolate, and mango). The determination of aerosol emission was examined using an inhalation exposure chamber. E-cigarettes were manually puffed using a syringe to generate e-cigarette aerosols and then delivered into the chamber. A 11-stage cascade impactor was used to characterize the size-fractionated (0.056 to 18 μm) mass concentrations of the e-cigarette aerosol in the chamber. We examined the effects of e-cigarette atomizer power (5 to 20 Watts) on e-cigarette aerosol mass emissions. The results showed that e-cigarette aerosol size distributions were unimodal with peaks between 0.56 and 1 μm across all atomizer power ranges. Increasing atomizer power from 5 to 20 W resulted in increasing mass median aerodynamic diameter (MMAD) from 0.95 to 1.22 μm. Furthermore, we found that an increase of 0.028 mg/puff in e-cigarette aerosol was associated with each 1

W increase in atomizer power.

Keyword:aerosol, consumer and personal care products, other (specify below), Electronic cigarette exposure

1053505
CHARACTERIZING MULTI-DECADAL LAND DYNAMICS USING A SATELLITE-BASED URBAN GREENNESS SCORE

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Abstract: The unprecedented urban expansion and densification over the past quarter century has impacted tree and vegetation cover (i.e. greenness). Nationally consistent and spatially explicit processes to assess temporal changes in urban greenness are often lacking. In this study, we addressed the issue by developing an urban greenness score for census dissemination areas (DAs) of 18 major Canadian urban areas. Greenness was calculated as a fraction on the 30x30 pixel level using a vegetation–brightness–darkness spectral unmixing model that was regionally calibrated and applied to a time series of freely available Landsat satellite imagery. Current greenness was quantified using the 2016 greenness fraction, summarized by mean on the DA-level, and classified using natural breaks into levels of "low", "moderate", or "high". Change in greenness was calculated by utilizing all 33 years of DA-level mean greenness in the non-parametric Theil-Sen estimator, and then categorizing the trend results into classes of "decrease", "no change", or "increase" based on one unit of standard deviation. Spearman correlation coefficients (ρ) ranging from 0.67 – 0.85 between our dataset and greenness estimated from high resolution Google Earth imagery confirmed the accuracy of the spectral unmixing method model. Despite an overall decreasing trend in greenness across Canada, most DAs sustained a moderate (∼20% – 40%) or low (≲ 20%) level of greenness between 1984 and 2016. Cities in the Canadian Prairies experienced the greatest increase in greenness since 1984, while the east coast maintained the most greenness over time. The results of this study parallel previous work, demonstrating a negative association between greenness and urban infilling, lower greenness levels in urban cores, and loss of greenness in the urban-rural transition zone. The urban greenness score represents an objective quantification of vegetation that may be easier to interpret than other common satellite-based spectral measures, such as the Normalized Difference Vegetation Index (NDVI), by providing proportional values. Additionally, the method is based on the Landsat archive, freely available at 30-m spatial resolution since 1984, providing an opportunity for enhanced spatiotemporal assessments of urban land dynamics globally. The urban greenness score may be applied in epidemiological cohort studies analysing longitudinal effects on health related to changes in urban greenspace exposure.

Keyword:spatial, environmental health, longitudinal metrics, Green space

1053530
Defining regional ecological boundaries for environmental chemical exposures

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Abstract: Chemicals are widely used in modern society, but determining their ecological exposures and adverse effects is challenging due to diverse pathways and ecosystem conditions. Protective thresholds for chemical pollution must be identified to determine a sustainable level of chemical pressure for existing and emerging exposures. Despite urgent relevance for global policy setting (e.g., Sustainable Development Goals), there are no established methods to quantify chemical pollution boundaries at relevant spatiotemporal scales. Here, we outline a framework to establish regional ecological boundaries for chemical pollution, and use pesticide case studies to discuss related challenges and ways forward. In step 1, toxicity-related chemical pressure on ecosystems is quantified. We developed a method to prioritize pesticides (using exposure potential, toxicity, etc.) to identify exposures likely to cause ecosystem damage. We then used this priority list to quantify country-level impacts (applying ecotoxicity characterization factors to calculated pesticide emissions) for a set of pesticide application scenarios in Europe, demonstrating that the top 35 pesticides cover 60% of cumulative ecosystem damage of 255 considered pesticides, while the bottom 150 cover <5%. In step 2, ecosystems' ability to withstand chemical pressure (i.e. their 'carrying capacity') is defined. We integrated data for Estonia to conduct geospatial analysis of crops, water body characteristics, and species density distributions, and compared the resulting maps at points in 2015 to highlight the importance of spatiotemporal data in carrying capacity development (e.g., water level variability affects pesticides' environmental fate). Finally in step 3, units and scales for chemical pressure (step 1) and carrying capacities (step 2) are aligned for comparison to define a 'safe space' wherein chemicals can be used without irreversible adverse ecological effects, and this space is allocated to entities contributing to the pollution pressure. We discuss methods to define and allocate the safe space (e.g., to individuals based on consumer expenditures), and outline concepts to improve allocation schemes. By expanding the three-step framework, human health impacts can be considered (e.g., by adjusting for healthcare capacity), and the full impact of existing and emerging environmental chemical exposures can be determined to protect human and ecological health and ensure sustainable chemical use globally.

Keyword:ecological exposure, chemical prioritization, pesticides

1053538

Association of phthalates exposure and oxidative stress biomarkers with wheeze, rhino-conjunctivitis and eczema in children

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Abstract: Previous evidences suggests that phthalates exposure and oxidative stress play a key role in relationship with the development and aggravation of respiratory and allergic symptoms. However, such findings are limited and inconsistent in human. Thus, in this study, we investigated the association of urinary phthalate metabolites and oxidative stress with wheeze, rhino-conjunctivitis and eczema in 386 children from Hokkaido, Japan. Urine

samples collected from 7 years old children were analyzed to determine concentration of DBP, BBzP, DEHP, and DINP metabolites and oxidative stress biomarkers [8-hydroxy-2′-deoxyguanosine (8-OHdG), hexanoyllysine (HEL), and 4-hydroxynonenal (HNE)]. Wheeze, rhino-conjunctivitis and eczema were assessed by ISAAC questionnaire filled by children's parents in addition to the children demography. Multiple regression model with adjusted covariates analysis was performed to evaluate the association of urinary phthalate metabolites and oxidative stress biomarkers with wheeze, rhino-conjunctivitis and eczema. WQS and BKMR analysis were used to explore the mixture exposure effect with the health outcomes. Wheeze, rhino-conjunctivitis, and eczema prevalence was 28.2%, 26.1%, and 20.7% respectively. Wheeze prevalence seems to be higher in children with higher BMI, and those living in old houses, and dampness. While rhino-conjunctivitis prevalence was higher in children with parental history of allergy. Children with wheeze showed higher level of ∑DEHP and ∑DINP metabolites than non-symptomatic children. While ∑DINP was high in children with eczema. Considering oxidative stress biomarkers, HEL was high in children with wheeze. We found ∑DEHP was associated with wheeze (odds ratio; 95% confidence interval 1.36; 0.96-1.94), while ∑DINP was related with wheeze (1.35; 1.01-1.83) and eczema (1.28; 0.95-1.72). Among oxidative stress biomarkers, significant association was exhibited only between HEL and wheeze (1.43; 0.98-2.08). The most highly weighted metabolites for wheeze, rhino-conjunctivitis and eczema were MiNP, MEHHP and OH-MiNP respectively. Considering BKMR analysis, strong association was observed between MiNP with wheeze, and OH-MiNP with rhino and eczema. This study demonstrates association of high molecular weight phthalates ∑DEHP and ∑DINP with wheeze and eczema in children.

Keyword:epidemiology, phthalates, environmental health, Oxidative stress

1053293

Distance to a ferro-manganese smelter and hair manganese in adults

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Abstract: Hair is a non-invasive biomarker of inhaled exposure to environmental manganese (Mn). Mn in hair (MnH) is associated with neurodevelopmental and neurodegenerative outcomes from elevated air Mn exposure, typical near mining, smelting, steel processing, and fossil fuel combustion facilities. While MnH distinguishes exposed and reference populations, its association with differing levels of exposures within exposed communities needs evaluation. We collected hair samples from a population-based sample of adult residents from three settlements within 1-3.5 km of a large Mn smelter in Meyerton, South Africa (N=160), and a comparable reference community (N=70) ~70 km away. After cleaning to remove exogeneous contamination, hair samples were digested and analyzed using inductively coupled plasma-mass spectrometry. To distinguish Mn exposure levels, we also collected Mn in ambient fine particulate matter (PM2.5-Mn) intermittently between October 2015-December 2018 in the exposed community and January-October 2020 in the reference community. Annual average PM2.5-Mn was 10±1 ng/m3 in the reference community. Relative to this, PM2.5-Mn was 17-fold greater in the exposed settlement most

frequently downwind from the smelter and 7-to-9-fold higher in the other two settlements; these ranges are comparable to total suspended Mn concentrations (200-330 ng/m3) near U.S. Mn-point sources. MnH was skewed, with medians of 3.6 ppm (25-75th percentiles: 2.3-6.0) and 21.5 ppm (25-75th percentiles:10.8-44.0) in the reference and exposed communities, respectively. Log(MnH) was higher in women than men in the exposed ($p<0.001$) but not the reference community ($p=0.7$); neither smoking nor alcohol use modified MnH. In the exposed community, a multivariable linear regression model adjusted for age, sex, and wind direction-weighted distance detected significant inverse correlation between log(MnH) and the distance from the participant's residence to the furnace stack ($\beta=-2.1$, 95% CI -3.5, -0.67). Without adjusting for direction, the association was stronger in the settlement more frequently downwind ($\beta=-0.49$, 95% CI -0.8, -0.18) than in another of comparable proximity ($\beta=-0.33$, 95% CI -0.57, -0.09). The results suggest that MnH can discriminate inter- and intra-community environmental exposure at levels with reported associations to adverse neurological outcomes. We plan to further evaluate the use of MnH in characterizing inhaled exposure using dispersion model estimates of PM2.5-Mn.

Keyword:biomarkers, air pollution, other (specify below), Manganese (Mn)

1053314

Urinary carboxylic acid metabolites as novel biomarkers of exposures to alkylated polycyclic aromatic hydrocarbons

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Abstract: Previous studies have found that alkylated polycyclic aromatic hydrocarbons (alkyl-PAHs) were more abundant in petrogenic sources (e.g., crude oil and its refined products) than pyrogenic sources of incomplete combustion. While urinary hydroxylated metabolites of unsubstituted PAHs have been widely used as biomarkers of PAHs exposures, little information is available as to the occurrence of alkyl-PAH metabolites. In this study, we have detected carboxylic acid metabolites of alkyl-naphthalene (2-NAPCA) and alkyl-phenanthrene (2-PHECA) in 314 urine samples repeatedly collected from 45 Los Angeles residents before, during, and after they spent ten weeks in Beijing in summers of 2014–2017. We found that traveling from Los Angeles to Beijing led to 348% (95% CI: 243 to 485%) and 209% (95% CI: 149 to 282%) increases in 2-NAPCA and 2-PHECA concentrations, respectively, which returned to baseline levels after participants came back to Los Angeles. The concentration ratio between 2-PHECA and hydroxy-phenanthrenes was significantly ($p < 0.05$) lower in Beijing (median: 0.40, IQR: 0.27–0.53) than in Los Angeles (median: 0.51, IQR: 0.32–0.77), where more than 5,000 active gas and oil wells were located. Consistently, the 2-PHECA level was significantly associated with ambient levels of fine particle and carbon monoxide in Beijing but not in Los Angeles. These results provided indirect evidence supporting the use of 2-PHECA to hydroxy-phenanthrene ratio as an index to reflect the relative exposure contributions from petrogenic and pyrogenic sources. From 2014 to 2017, the concentration ratio of 2-PHECA to hydroxy-phenanthrenes increased by 28.7 (95%CI: 12.3 to 47.6) %/yr in Los Angeles and 18.6 (95%CI: 7.9 to 30.3) %/yr in Beijing, likely resulted from both cities' efforts to reduce pyrogenic emissions (e.g., vehicle exhaust). Levels

of hydroxy-phenanthrenes were significantly associated with increased urinary levels of malondialdehyde, an oxidative stress biomarker, while 2-PHECA did not. These results may suggest greater pro-oxidative effects of unsubstituted PAHs from pyrogenic sources as compared with alkyl-PAHs from petrogenic sources.

Keyword:air toxics, biomarkers, biomonitoring

1053607

Exposure endocrine disrupting chemicals: A case study from Slovenia

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Abstract: Phthalates (PHs), DINCH, bisphenols (BPs), parabens (PBs), and triclosan (TCS) are representatives of high production volume chemicals with known or assumed endocrine activity. These compounds enter the human body via ingestion, inhalation, and dermal absorption where they undergo rapid metabolism and urinary excretion within hours after exposure. They are - despite their chemical instability – frequently determined in environmental and human matrices in response to their ubiquitous presence in consumer products such as plastics, and personal care products. Within the first national human biomonitoring program in Slovenia (2008–2014), the exposure of (n=299) men and (n=304) lactating women from 12 regions in Slovenia has been investigated. We determined median concentrations in the range of 0.23–27.9 ng/mL for PHs and DINCH,

Keyword:biomonitoring, cumulative exposure, environmental health

1053629

Temporal trends for percent differences in consumer product endocrine disrupting chemicals among women of reproductive age in the United States: Racial/ethnic and acculturation disparities, NHANES 1999-2016

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Abstract: Endocrine disrupting chemicals are commonly found in consumer products and are related to various health risks in women of reproductive age. Previous studies have found disparities in chemical exposures by race/ethnicity and immigration status, but additional research is needed to understand how these disparities change over time. Objectives We examined time trends of disparities by race/ethnicity and immigration status in exposures to phenols, phthalates, and per- and polyfluoroalkyl substances (PFAS) among women of reproductive age from the National Health and Nutrition Examination Survey (NHANES). Methods We analyzed concentrations of 20 biomarkers of phenols, phthalates, and PFAS among women aged 15-49 years from NHANES 1999-2016. Survey-weighted linear regression models were used to assess percent (%) differences in chemical concentrations by race/ethnicity (compared to non-Hispanic White) and by immigration status (compared to US-born) in each survey cycle, and linear time trends across all cycles, adjusted for age and income-to-poverty ratio (all models), and creatinine (for urine analyses). Results Compared to non-Hispanic White women, levels of 2,5-dichlorophenol (2,5-DCP), methylparaben, and

propylparaben were persistently higher in all non-White race/ethnicity groups across all years, with % differences of 2,5-DCP increasing over time. Levels of monoethyl phthalate were persistently higher in Mexican American, other Hispanic, and non-Hispanic Black women, with % differences increasing over time among Mexican American and non-Hispanic Black women. Percent differences in mono-isobutyl phthalate, perfluorohexane sulfonate and perfluorononanoic acid decreased over time among non-Hispanic Black women, while % differences in perfluorooctane sulfonate (PFOS) increased over time among Other non-Hispanic women. Compared to US-born women, levels of 2,4- and 2,5-DCP were persistently higher in recent and long-term immigrants across all years. Percent differences in mono-n-butyl phthalate (MnBP), triclosan, perfluorooctanoic acid and PFOS increased over time among recent immigrants, and % differences in MnBP and the sum of di-2-ethylhexyl phthalate metabolites increased over time among long-term immigrants. Conclusions Persistent or changing disparities in chemical exposures by race/ethnicity and immigrant status existed among women of reproductive age in the US. Understanding reasons for these trends could help to inform policy and interventions.

Keyword:consumer and personal care products, phthalates, other (specify below), disparities, race, acculturation

1053380

Baseline exposure to Rare Earth Elements by the general population of Canada

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Abstract: The rare earth elements (REE) are a set of seventeen metallic elements, which are chemically similar. Canada has some of the largest known reserves and resources of REEs in the world, estimated at over 15 million tonnes of rare earth oxides. At present, Canada is not a producer of REEs. China leads the REE industry by producing more than 90% of the current REE requirements. REEs are used in high-tech applications in many industrial sectors including electrical and electronics, automotive, renewable energy, aerospace, medical, agriculture and defence. An increase in occupational and environmental exposures to REE can be expected due to the recent increase of use in industrial and developmental sectors, presence in consumer products, and the increase of electronic waste. Occupational epidemiological studies conducted in workers in REE mining and processing industries show elevated exposure to REE is associated with increased risk of adverse health conditions. Therefore, it may be important to monitor if REE exposure to the Canadian general population is changing with time. National-level biomonitoring data can provide baseline REE levels of Canadians. Whole blood concentrations of some REEs: Cerium, Lanthanum, Neodymium, Praseodymium and Yttrium were included in a recent biobank study (n=5752). Whole blood samples from the biobank of the Canadian Health Measures Survey (cycle-2) were analysed by Inductively Coupled Plasma Mass Spectrometry to generate national-level REE data. The 95th percentile of the whole blood concentrations of these REEs were below their limit of detections, which were considered low enough ranged from 0.02 to 0.06 µg/L. In addition, Canadian REE baseline monitoring data are available for house dust, indoor air, outdoor air and biota. The nationally representative Canadian House Dust Study (n=1025 homes), measured all RREs in house dust except thulium and lutetium. The data from

Canadian National Air Pollution Surveillance Program and modelled data, showed indoor and outdoor PM2.5 air concentrations of REE to be below 0.37 mg/m3. A smaller scale field based study conducted in the eastern Canadian Arctic (n=339) measured REE concentrations in biota from freshwater, marine, and terrestrial ecosystems. Future monitoring data and these national-level baseline data will enable the researchers, risk assessors and academia to monitor the potential changes in exposure related to the increased usage of REE overtime.

Keyword:biomonitoring, environmental health, metals, Rare Earth Elements

1053073

Urinary concentrations of glyphosate and glufosinate herbicides in Canadian pregnant women: the MIREC Study

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Abstract: Background: Glyphosate is the most widely used herbicide in agriculture today. Glufosinate is a broad spectrum herbicide increasingly used on glyphosate-resistant weeds. Despite the widespread use and potential for exposure to these herbicides, biomonitoring data – which is critical for risk assessment – is sparse. Objective: We measured concentrations of glyphosate, glufosinate, and their respective primary metabolites aminomethylphosphonic acid (AMPA) and 3-methylphosphinicopropionic acid (3-MPPA) in stored first trimester single spot urine specimens from the Maternal-Infant Research on Environmental Chemicals (MIREC) study. MIREC is a multicenter Canadian cohort study of 2001 pregnant women recruited from 10 urban sites between 2008 and 2011. Methods: We used ultra-performance liquid chromatography coupled to tandem mass spectrometry with sensitive limits of detection (0.08 µg/L-0.09 µg/L) to measure urinary concentrations of these herbicides and their metabolites. We standardized the urinary concentrations for specific gravity to calculate summary statistics for the entire sample and used specific-gravity adjusted ANCOVA models with the raw concentrations to calculate group specific summary statistics. We quantified associations with maternal characteristics using ANCOVA. Results: Of the 1880 women with urine samples, 74% and 72% of women had detectable concentrations of urinary glyphosate and AMPA respectively. In contrast, 0.5% and 5.7% of women had detectable concentrations of glufosinate and 3-MPPA. The geometric mean (GM) (standard deviation) concentrations of glyphosate and AMPA were 0.24 (2.64) µg/L and 0.22 (2.34) µg/L with ranges from the limit of detection to a maximum of 3.9 µg/L for glyphosate and 6.1 µg/L for AMPA. These two chemicals were moderately correlated (r=0.57). Glyphosate and AMPA concentrations did not differ according to urine collection season, self-reported use of herbicides, or maternal sociodemographic factors. Conclusions: About two-thirds of women in this large, primarily urban cohort had detectable concentrations of glyphosate and its metabolite AMPA. Glufosinate and 3-MPPA were rarely detected. Our findings suggest that personal herbicide use and season are not important determinants of exposure to glyphosate or AMPA. Future investigations in the MIREC cohort will explore dietary sources of exposure and potential effects on maternal and child health.

Keyword:pesticides, biomarkers, epidemiology

1053110

Consumer and commercial products containing volatile carcinogens and reproductive and developmental toxicants: Priorities for risk reduction

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Abstract: Consumer and commercial products are important sources of exposure to many harmful chemicals. To quantify the potential scope of exposure and to identify priorities for risk reduction, we analyzed consumer and commercial product ingredient data collected by California's Air Resources Board (CARB), which conducts periodic surveys of volatile chemicals in California consumer products. While CARB collects data to model and mitigate smog-forming pollutants, we analyzed the presence and emissions of chemicals regulated as carcinogens and/or reproductive/developmental toxicants under the California Safe Drinking Water and Toxics Enforcement Act (Prop 65). We conducted a cross-sectional analysis of the 2013 CARB product ingredient survey, prioritizing both chemicals and consumer product categories based on their likelihood of causing individual-level exposures, workplace-related exposures, and population-level exposures. To further understand potential population-level exposures, we also analyzed the CARB 2015 state-wide emissions estimates of volatile chemicals from consumer products. Thirty-five Prop-65 listed chemicals were reported in the CARB product ingredient survey. Of the 382 product categories in the CARB ingredient data, 197 contained Prop 65-listed chemicals. Among the 35 Prop-65 listed chemicals reported as product ingredients, formaldehyde, diethanolamine, and N-methyl-2-pyrrolidone were most frequently present in products across all three exposure scenarios examined: for individuals, in workplaces, and for the general population. In addition, methylene chloride, naphthalene, and styrene showed potential for both occupational and population-level exposures, and p-dichlorobenzene and tetrachloroethylene showed high potential for population-level exposures. A number of these Prop 65 chemicals commonly present in products have been prioritized for risk management under EPA's Toxic Substances Control Act, including methylene chloride, tetrachloroethylene, and N-methyl-2-pyrrolidone. We identified several product categories, including Furniture Maintenance Product, General Purpose Degreaser, Heavy-Duty Hand Cleaner/Soap, Multi-purpose Lubricant, and Paint Remover or Stripper, as potential targets for reformulation. We highlighted carcinogens and reproductive/developmental toxicants in consumer and commercial products sold in California, pinpointing opportunities to reduce potential exposures and health risks.

Keyword:consumer and personal care products, chemical prioritization, VOCs

1053244

Developing scientific workflows for exposure assessments: a case study with 1,4-dioxane exposure

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Institutes for Science and Education, [3]California Department of Toxic Substances Control, [4]3California Department of Toxic Substances Control, [5]US Environmental Protection Agency

Abstract:A scientific workflow ("workflow", hereafter) is designed to execute a series of data manipulation and computational steps to provide outputs tailored to decision-making contexts. For chemical exposure assessments, workflows are useful tools for making well informed, replicable estimates of exposure, especially for chemicals with complex exposure scenarios. For emerging contaminants of concern, workflow development may be hampered by the lack of available data with which to parameterize exposure models. In this situation, data rich proxies may be useful for developing more generalizable workflows. We developed a workflow to estimate exposure to 1,4-dioxane, a persistent and mobile organic chemical that is considered to be a likely human carcinogen by the U.S. EPA. 1,4-Dioxane is used as a solvent in industrial applications and occurs as an unintended byproduct of ethoxylated surfactants in some personal-care products such as detergents and soaps. Both sources may contribute to human exposure and to wastewater contamination, with potential further contamination of down-stream drinking water sources. Our workflow employed the EPA-based simulation modeling tool, SHEDS-HT, to model exposure scenarios to 1,4-dioxane under several conditions, including differences in drinking water source and assumed prevalence of 1,4-dioxane in consumer products. We found that human exposure was primarily driven by water consumption, and was highest for those exposed to contaminated ground water. Meanwhile, down-the-drain contamination was likely driven by consumer product use, with model estimates significantly influenced by the assumed prevalence of 1,4-dioxane in products. These model-based results are bolstered by empirical 1,4-dioxane concentrations collected at wastewater plants that are within 1 order of magnitude of most down-the-drain estimates. Lastly, the workflow developed for this assessment can readily be adapted to additional exposure scenarios for 1,4-dioxane and may serve as a starting template for modeling exposure to other persistent and mobile organic chemicals. 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.

Keyword:aggregate exposure, consumer and personal care products, other (specify below), Simulation modeling

1052980

Urinary concentrations of major phthalate and alternative plasticizer metabolites in children of Thailand, Indonesia, and Saudi Arabia, and associated risks

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Abstract: Phthalates are widely used in consumer products, and they are well-known for

adverse endocrine outcomes. Di(2-ethylhexyl) phthalate (DEHP), one of the most extensively used phthalates, has been rapidly substituted by alternative plasticizers in many consumer products. The aim of this study was to assess urinary phthalate and alternative plasticizer exposure, and associated risks in children of three Asian countries with different geographical, climate, and cultural characteristics. Children were recruited from elementary schools of Saudi Arabia (n=109), Thailand (n=104), and Indonesia (n=89) in 2017-2018 and their urine samples were collected. Metabolites of major phthalate and alternative plasticizer were measured in the urine samples by HPLC-MS/MS. Urinary levels of diisononyl phthalate (DiNP), diisodecyl phthalate (DiDP), di-2-ethylhexyl terephthalate (DEHTP), and 1,2-cyclohexane dicarboxylic acid diisononyl ester (DINCH) metabolites were the highest in Saudi children. Urinary metabolites of DEHP substitutes were greater than those of DEHP among Saudi children. Hazard index (HI), derived for the plasticizers for which anti-androgenicity based reference doses (RfDAA) are available, were >1 in 86%, 48%, and 80% among Saudi, Thai, and Indonesian children, respectively. DEHP was identified as a common major risk driver for the children of all three countries, but other phthalates such as DnBP or DiBP were also important, depending on country. Among alternative plasticizers, urinary DEHTP metabolites were detected at levels as high as those of DEHP metabolites, and about 4% of the children exhibited the exceedance of its human biomonitoring (HBM)-I value in Saudi children. Priority plasticizers that were identified among the children of three countries warrant refined exposure assessment for source identification. [Acknowledgement] This work was supported by a grant from National Research Foundation of Korea (NRF) grant (NRF-2020R1A2C3011269).

Keyword:phthalates, risk assessment, children

1052744

Assessment of Human Exposure to Per- and Polyfluoroalkyl Substances Using New Generation Online Solid-Phase Extraction Ultra High Performance Liquid Chromatography Tandem Mass Spectrometry

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Abstract: Human exposure to widely used per- and polyfluoroalkyl substances (PFAS) is a significant environmental and public health concern due to more reported evidence of adverse effects of PFAS on humans. We have been monitoring a dozen most persistent legacy PFAS (e.g., PFOS, PFOA, PFOSA) in human serum using a Symbiosis/SCIEX 4000 Qtrap® online solid phase extraction liquid chromatography-tandem mass spectrometry System (SPE LC-MS/MS) for more than ten years. Recently, the new generation of on-line SPE LC-MS/MS system, the CHRONECT® Symbiosis Online SPE Ultra High Performance Liquid Chromatography (UHPLC) system (Axel Semrau®, Germany) coupled with a SCIEX Triple Quad™ 6500$^+$ Mass Spectrometer (Sciex, USA), was adapted and validated in our lab. Compared to the previous method, the new system achieved a 2x faster analysis time per sample and approximately an 8-fold better sensitivity. The new method uses CHROSPE C18 HD as online extraction cartridge. A CORTECS™ C18 column (Waters, USA) and an ACQUITY UPLC ™ BEH C18 column (Waters, USA) are used as delay column and

analytical column, respectively, with a 10-minute gradient program. The accuracy and precision for quality control samples of the legacy PFAS are 96.7-115.1% and 3.4-8.1%, respectively, with the calibration curve ranges of 0.01 ng/mL to 25 ng/mL (0.04 ng/mL to 100 ng/mL for PFOS). The new method has successfully passed the annual international performance test "Arctic Monitoring and Assessment Programme 2021" with z-scores < 1 for the eight PFAS tested. Results from real human serum analysis also showed good agreements in all PFAS tested between the two online SPE LC-MS/MS systems, with the R2 > 0.95. Our preliminary data also indicate that the newly developed online SPE UHPLC-MS/MS method can be expanded to analyze additional 25 to 30 new/replacement PFAS compounds, including additional perfluorocarboxylic acids (PFCAs), perfluorosulfonic acids (PFSAs), fluorotelomers, ether based perfluoroalkyl acids (PFAAs) and other emerging PFAS such as Gen-X, ADONA and F-53B, when using CHROSPE C18 DVB as on-line extraction cartridge. Therefore, our new method provides not only a faster PFAS analysis throughput of human serum samples but will also provide a more extensive PFAS compound analysis and better sensitivities. Disclaimer: The views expressed herein are those of the authors and do not necessarily reflect those of the California Department of Toxic Substances Control.

Keyword:PFAS, biomonitoring, analytical methods

1052799

The performance of Dried Blood Spots (DBS) for the assessment of lead exposure: a narrative review with a systematic search

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Abstract: Dried blood spot (DBS) sampling is one of the most used, alternative micro-sampling techniques (usually <100 µL) to traditional venipuncture. Since it was first developed in 1963, DBS has been applied worldwide in diverse fields, including newborn screening programs (NBS), for lead (Pb) exposure screening. While this sampling technique has been successfully applied to assess Pb exposure, there remain outstanding gaps that have prevented wider adoption of DBS-based methods. To our knowledge, the identification of these gaps has yet to be synthesized using quantitative and qualitative approaches, without which we cannot help move the field forward. The aim of this study was to perform a systematic search of the literature to help identify the main limitations of DBS in the analysis of Pb exposure, and to increase our knowledge about what is needed to improve this sampling technique so that it may serve as a robust alternative to whole blood sampling. First, we performed searches on three databases for three main terms: DBS, lead exposure, and assessment/monitoring. Second, we screened our results applying inclusion and exclusion criteria to obtain a final number of acceptable articles. Finally, we performed a quantitative and qualitative discussion on the main limitations of DBS reported in the included articles. We found studies from ten countries, with most of them performed in the U.S. (54.2%). Most studies used Whatman no. 903 filter cards (29.4%) or Schleicher and Schuell no. 903 cards (24.4%) and reported using controlled blood volumes (38.2%). Most of the studies in the decade of the 90s used graphite furnace atomic absorption (GF-AAS) (32%) and in general, Inductively Couple Plasma Mass Spectrometry (ICP-MS) is the most used analytical technique for the analysis of DBS (37.5%). We identified four aspects consistently evaluated as potential limitations of DBS-based methods: 1) analytical sensitivity/LoD, 2) capillary and

venous blood correlation, 3) contamination issues and 4) the hematocrit effect. These aspects are commonly found in the literature as the main drawbacks to increase the adoption of DBS sampling in biomonitoring programs, however, some of them have improved in the last years and there are opportunities to overcome these challenges that can further increase the reliability of DBS sampling in the assessment of Pb exposure.

Keyword:lead (Pb), biomonitoring, biomarkers

1052813

Exposure to Particle and Volatile Organic Compound Emissions from Consumer Level 3D Printers

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Abstract: Consumer level or desktop fused filament fabrication (FFF) 3D printers are widely used in schools, offices, and residences; users and especially vulnerable populations like children are exposed to emissions that could have adverse health impacts. Studies have shown particles, particularly ultrafine particles, and volatile organic compounds (VOCs) being emitted from FFF 3D printers, however the health impacts induced by exposure to the emissions are not well known. This study systematically characterized particle and VOC emissions from multiple FFF 3D printers with various print materials in accordance to a standard test method and estimated the potential health impacts of the emissions based on experimental assessments and modelling. The emission levels and characteristics of various sized particles and numerous VOCs were measured in an exposure chamber. The effects of operation parameters on emissions, including print temperature, printer brand, print material and brand, were also investigated. Particle toxicity was assessed by in vivo exposure, in vitro cellular and chemical assays; the estimated exposure effects in different indoor environments were compared to those of ambient fine particulate matters. The exposure levels of hazardous VOCs in various indoor environments were estimated using an indoor exposure model and evaluated with indoor air quality regulations and criteria. Finally, strategies of mitigating exposure to 3D printing are suggested.

Keyword:particles, VOCs, other (specify below), 3D printer

1049464

The IMAGE project - Ireland's bioMonitoring Assessment of Glyphosate Exposures – an environmental exposure assessment of glyphosate among Irish families

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Abstract: Glyphosate is a non-selective herbicide used extensively in agriculture, horticulture and amateur gardening, resulting in ubiquitous environmental exposure. Human exposures can occur through occupational or amateur pesticide uses or by ingestion of food with

glyphosate residues. In 2015, glyphosate was classified as '2A probably carcinogenic to humans' by the International Agency for Research on Cancer (IARC), intensifying the international interest in this chemical. The Human Biomonitoring for Europe (HBM4EU) initiative, aiming to advance and harmonize human biomonitoring in Europe, has classed glyphosate as a priority substance for evaluation. Studies among populations in Europe and the United States have identified glyphosate exposures, and further data is required to evaluate exposure levels among the general populations. Using a human biomonitoring strategy, an Irish pilot study reported detectable glyphosate levels of between 0.80 – 1.35 μg L−1 in 20% of the urine samples collected (LOQ 0.5 μg L−1). However, ongoing research made it obvious that it is necessary to quantify glyphosate exposures below levels of 0.5 μg L−1 for evaluating more informative population medians. Moreover, it is important to also measure glyphosate's main environmental metabolite, aminomethylphosphonic acid (AMPA) to gain a more comprehensive overview of human exposures to glyphosate and AMPA body burdens. The IMAGE, Ireland's bioMonitoring Assessment of Glyphosate Exposures, research project aims to conduct an environmental assessment of glyphosate exposures among Irish farm and non-farm families. Human biomonitoring samples were collected among parents and children of 53 farm families and 13 non-farm families. Along with urine sample collection, participants were asked to complete study questionnaires developed in line with HBM4EU protocols to collect contextual information on diet, occupation, lifestyle and health. Additionally, an analytical method has been developed in this project to analyse urine samples for both glyphosate and AMPA, with improved sensitivity (LOQ 0.05 μg L−1). Details of the new novel chemical analysis method will be presented at the conference. Additionally, preliminary study results of the population's exposures among parents and children will be presented. The risk related to these exposure levels will be evaluated through comparison with health-based guidance values.

Keyword:biomonitoring, pesticides, sampling methods, glyphosate, environmental exposures

1049937

Case Study: Comparison of approaches for the exposure assessment of a semi-volatile flame retardant, triphenyl phosphate, used in an upholstered chair

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Abstract: Semi-volatile organic compounds (SVOCs), when compared to volatile organic compounds (VOCs), tend to emit more slowly and steadily, and to sorb to surfaces, suspended particulates and settled dust. Exposure assessments of SVOCs require both measured data and modeling approaches that quantify emission, fate, and transport of SVOCs in the indoor environment. When experimental parameter data are not available for a chemical or product of interest, estimated parameters, based on physical-chemical properties, can be utilized. Triphenyl phosphate (TPP, CAS#115-86-6) is one of the 20 high-priority chemicals under evaluation for EPA's Lautenberg Chemical Safety Act (amended Toxic Substances Control Act). TPP is a relatively well-studied SVOC and has sufficient experimental data for comparison of assessment approaches. This case study used existing

experimental data and models for indoor exposure assessment of SVOCs to characterize exposures to TPP. It highlighted differences in experimental techniques and modeling assumptions for estimating emissions and migration of TPP from an upholstered chair into the indoor environment. Exposure pathways considered in this case study include dermal, inhalation, and oral. Dermal exposure occurs via direct skin contact with product while sitting. Inhalation exposure occurs via gaseous emissions and particulate formation from the product. Oral exposure can occur via hand-to-mouth, mouthing of product, and via ingestion of particulate (settled dust). To the extent possible, human exposure factors (i.e., inhalation rates, ingestion rates, and dermal surface area), as well as building characteristics (i.e., room size, air-exchange rates) were kept constant in the case study, so that differences in exposure estimates were attributed to differing experimental and modeling assumptions. The case study characterized the quality, certainty, and uncertainty of measurements, estimates, and parameters and how these were integrated into each exposure pathway, and it provided recommendations for future SVOC exposure assessments. Disclaimer. The views expressed in this abstract are those of the author(s) and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency, National Institute of Standards and Technology, or Consumer Product Safety Commission.

Keyword:SVOCs, built/indoor environment, consumer and personal care products

1050981

Breast-feeding duration and maternal age contributing to the body burden of perfluorinated alkylated substances (PFAS) – results from the German Environmental Survey for Children and Adolescents 2014–2017 (GerES V)

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Abstract: Perfluoroalkyl substances (PFAS) such as perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) are ubiquitously found in humans across all age groups. The German Environmental Survey for Children and Adolescents carried out from 2014 to 2017 (GerES V) revealed detectable blood plasma levels of PFAS in all participants. Two third of the participants had blood plasma levels above the limit of quantification (0.25-0.50 µg/L) simultaneously for PFOA, PFOS, and perfluorohexane-1-sulphonic acid (PFHxS). The health-based guidance values I (HBM-I) derived by the German Human Biomonitoring Commission of 2 µg/L for PFOA and 5 µg/L for PFOS were exceeded by 21% and 7% of the participants. For these participants adverse health effects cannot be ruled out with sufficient certainty. Another 0.2% even exceeded the HBM-II value for PFOS of 20 µg/L for the general population and 10 µg/L for women of child-bearing age, respectively, which is regarded as intervention or action level. PFAS are found to substantial extent even in the youngest children born after the ban of PFOS in 2006, underlining the problematic and long-lasting effects of persistent chemicals. PFAS contamination is evident globally in various environmental compartments, food as well as breast milk. The aim of this study is to quantify the effect of relevant sources of PFAS exposure on children and adolescents in Germany, including various sociodemographic characteristics, living environment, dietary preferences, breast-feeding history, and tap water contamination. Breast-feeding duration and maternal age are significantly correlated with log-transformed plasma concentrations of PFOA, PFOS, and

PFHxS (pearson correlation coefficients 0.12-0.24, $p < 0.001$) – i.e. higher maternal age and longer breast-feeding duration are associated with higher PFAS levels in the offspring. Multivariate analyses are used to quantify the contribution of exposure sources to internal PFAS exposure. The results suggest that, while breast-feeding is generally encouraged due to its various positive health effects, recommendations regarding breast-feeding duration should consider the PFAS burden of mothers especially when they have their first child only at relatively high age.

Keyword:children, biomonitoring, PFAS

1050992

Development of a human biomonitoring method for assessing the exposure to ethoxyquin in the general population

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Abstract: Ethoxyquin (EQ) is commonly used as an antioxidant in animal feeds. Although EQ is not permitted for usage in food products for humans within the EU, residues of EQ and its transformation products could be determined in food of animal origin. Despite its widespread use and concerns on its toxicological profile, no information about the systemic exposure to EQ in the general population is available. Hence, we developed a human biomonitoring (HBM) method for EQ. Our approach included a metabolism study with five subjects, who were administered an oral dose of 0.005 mg EQ/kg body weight. Unchanged EQ and the major metabolite 2,2,4-trimethyl-6(2H)-quinolinone (EQI) were identified as urinary excretion products of EQ. While small amounts of EQ could be determined in high concentrated samples from the metabolism study only, 28.5 % of the orally applied EQ dose could be recovered as EQI. Consequently, an analytical method for EQI (LOQ = 0.03 µg/L) in urine based on LC-MS/MS comprising enzymatic glucuronide hydrolysis and salt-assisted liquid-liquid extraction was developed and fully validated according to FDA guidelines on bioanalytical method validation. The method was applied to the samples from the metabolism study in order to determine the toxicokinetic parameters of EQI, the potential biomarker of exposure. EQI is rapidly excreted after absorption with a maximum at about 1.3 hours. On average, 28.5 % of the total dose were excreted 48 h after dosing as EQI and thereof, 99.4 % were excreted in the first 24 h after dosing. The mean elimination half-life amounted to 0.83 h. The urinary excretion factor Fue (24 h) was calculated to be 0.2834, which means that 28.3 % of the systemic exposure dose of EQ are excreted as EQI within the first 24 hours. In addition, 53 urine samples from the general population were investigated. EQI could be quantified in 11 (21 %) of the samples in levels up to 1.7 µg/L urine, proving the suitability of the developed method to assess EQ exposure in HBM studies.

Keyword:metabolism, biomarkers, biomonitoring

1051253

Microplastics and Nanoplastics: Review of Biomonitoring Data Needs to Estimate Human Exposures

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Abstract: Plastics have many applications in numerous industries and everyday uses, and everywhere. The production, use, and disposal of plastic products is increasing everyday, but waste management is insufficient to prevent its accumulation in landfills, waste sites, wastewater and other environmental medias. The production of microbeads, plastic waste weathering and breakdown into microplastics and nanoplastics (MNPLs). MNPLs are ubiquitous, pervasive environmental pollutants and may pose an emerging public health threat. We explored the importance of biomonitoring data needs and the feasibility of biomonitoring for estimating human exposures to MNPLs. We focused on articles published in the last seven years using PubMed and Google Scholar. We used a systematic snowballing approach, combining outline subheadings and keywords related to MNPLs in the human body and MNPLs biomonitoring. From 10,000 identified published articles, we excluded all but 56 journal articles with a focus on human MNPL exposure estimates, among them, only seven original articles in which MNPLs were quantitated in biological samples. Chemicals of concern include polymers such as polyvinyl chloride [PVC], polystyrene [PS], polyurethane [PUR]), plastic additives such as phthalate plasticizers, bisphenol A, polycyclic aromatic hydrocarbons polyfluoroalkyl substances, polybrominated diphenyl ethers, and toxic metals including cadmium, nickel, chromium, lead, and mercury. These seven studies reported microplastics (MPs) in human tissues including lungs, liver, adipose tissue, spleen, kidneys, head hair, skin, saliva, and placenta. Identified polymers were polyethylene terephthalate, high-density polyethylene, polypropylene, polycarbonate, polyethylene, PS, PVC, polyamide, PUR, polyvinyl butyral, polybutylene terephthalate particles in a wide range of numbers and micro sizes. The National Health and Nutrition Examination Survey has biomonitoring methods for some for plastic additives and toxic metals. However, these methods cannot determine whether polymers or other substances are the sources of the toxic substances. Identified gaps, include data needs for biomarkers of exposures or effects, standardized sampling, and analytical methods to estimate route specific contributions and the total exposure burden and toxicological data. Identified resources will allow identifying partners and priorities towards future direction on MNPLs human exposure and health effect assessments.

Keyword:biomonitoring, particles, other (specify below), Plastic polymers, microplastics, nanoplastics, body burden, exposure

1051356

Novel data for persistent environmental chemicals in pooled serum from the Canadian Health Measures Survey 2007 to 2017

K. Werry, A. Crew, S. Karthikeyan, C. MacKinnon-Roy, T. Pollock, J. Willey, J. Yome, A. St-Amand; Health Canada

Abstract: The Canadian Health Measures Survey (CHMS) is a direct health measures survey conducted by Statistics Canada, in partnership with Health Canada and the Public Health Agency of Canada. The National Biomonitoring Program measures baseline levels of

environmental chemicals in Canadians through the CHMS and publishes nationally-representative results. Recently, novel biomonitoring datasets from pooled samples collected between 2007 and 2017 were released. This work presents the first baseline levels in Canadians for persistent environmental chemicals measured in pooled serum from Canadians aged 3 to 79 years. Serum samples were collected from approximately 21,000 CHMS participants aged 3-79 years in cycles 1, 3, 4 and 5. The pooling strategy was designed to generate nationally-representative estimates for each age (3–5, 6–11, 12–19, 20–39, 40–59 and 60–79 years) and sex group. Each pool comprised 71–133 individual serum samples from the approximately 5,500 participants for each cycle. Minimum, maximum and mean concentrations were calculated for each chemical for the total survey population as well as for different age and sex groups for each cycle. This work includes the first nationally representative multi-year datasets in Canadians for 54 chemicals including dioxins, furans, polychlorinated biphenyls (PCBs) and brominated flame retardants. Comparing data across time periods for a subset of chemicals, including PCBs, there appear to be decreasing trends while for others, such as dioxins and furans, levels appear to be unchanged over time. These datasets are also unique in that they include data for young children aged 3 to 5 and 6 to 11 years. For many of the persistent organic pollutants, older individuals generally appear to have higher concentrations when compared to younger individuals. These datasets provide insight into the long lasting presence in human biological matrices for some persistent organic pollutants, even years after being regulated. As we turn our attention more and more to new emerging compounds, it reminds us of the importance of continuing our efforts in generating biomonitoring data for legacy substances such as dioxins and furans. Moreover, the trends in exposure generated help to inform the performance evaluation of risk management actions intended to reduce exposures and health risks from specific chemicals.

Keyword:environmental health, biomonitoring, other (specify below), persistent organic pollutants

1052326

Determinants of Exposure to Endocrine Disrupting Chemicals Following Hurricane Harvey

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Abstract: Hurricane Harvey was a category four storm that induced catastrophic flooding in the Houston metropolitan area. Multiple industrial complexes released excess emissions due to unplanned shutdowns or infrastructural damage as a result of the hurricane. Additionally, 13 of the 41 superfund sites within Harris County, Texas flooded. Public health concerns were immediately raised regarding potential exposure to toxic chemicals from the excess industrial releases and flooded superfund sites. A multi-insititutional team formed to deploy personal passive sampling devices in the form of silicone wristbands immediately after the hurricane to determine whether the flood had impacted personal chemical exposure. Participants (n=173) wore a wristband for seven days and completed a questionnaire to determine various flood related demographic variables. This included information necessary

to calculate an Area Deprivation Index (ADI), which was used to measure a participant's socioeconomic status as well as gage exposure to flooding (i.e. home flooding status, amount of time spent in a flooded home, participation in flood clean-up activities and degree of flooding in home). We analyzed each wristband for 1,530 chemicals. Additionally, we compared the list of chemicals we analyzed to the United Nations and Danish EPA list of endocrine disrupting chemicals (EDCs). Similar exposure profiles to EDCs existed across participants, independent of home flooding or flood clean up status, and flood amount in home. The most profound finding related to flood status is that participants who remained in flood-damaged homes during remediation had higher levels of exposure to multiple EDCs including lilial, triphenyl phosphate (TPP), and bis(2-ethylhexyl) phthalate compared to participants who moved after home flooding. Most of the variables studied that were associated with EDC exposure were demographic (i.e. participant ADI, race/ethnicity, and participant neighborhood). A high ADI (low socioeconomic status), identifying as Black/African American or Latino, and certain neighborhoods were all associated with increased exposure to EDC's in general and the specific EDCs lilial, TPP, butylated hydroxytoluene, butyl benzyl phthalate, and bis(2-ethylhexyl) phthalate. Moderate collinearity exists between these demographic variables and time spent in flooded home where individuals living in lower income neighborhoods were more likely to remain in their flood-damaged homes during remediation.

Keyword:environmental justice, exposure factors, other (specify below), passive samplers, disaster research

1052592

Current breast milk PFAS levels in the US and Canada: After all this time why don't we know more?

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Abstract: Background. Despite twenty years of biomonitoring studies of per- and polyfluoroalkyl substances (PFAS), we have a limited understanding of concentrations in breast milk from the US and Canada. The lack of information on PFAS levels in breast milk and the implications for breastfed infants and families were brought to the forefront by communities impacted by PFAS. Objectives. To: 1) review published PFAS breast milk concentrations in the US and Canada; 2) estimate breast milk PFAS levels from serum concentrations in national surveys and communities impacted by PFAS; and 3) compare measured/estimated milk PFAS concentrations to screening values. Methods. We identified three studies reporting breast milk concentrations in the US and Canada. To estimate breast milk PFAS concentrations, we multiplied publicly available geometric mean (GM) and 95th percentile serum PFAS concentrations from two national surveys (only women) and six communities impacted by PFAS (men and women) by milk:serum partitioning ratios for four PFAS: perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA). Milk:serum ratios were identified

from four previous studies with sample sizes ranging from 12 – 100 paired milk and serum samples. Breast milk concentrations were compared to Child Environmental Media Evaluation Guides (EMEGs) developed by the Agency for Toxic Substances and Disease Registry (ATSDR) for drinking water. Discussion. All measured breast milk concentrations of PFOA and PFOS exceeded the Child EMEGs, while most measured PFNA and PFHxS concentrations in breast milk were below the Child EMEGs. All estimated GM and mean breast milk PFOA and PFOS concentrations exceeded the Child EMEGs. For two of six communities, the estimated GM concentrations of PFHxS and PFNA were close to – or exceeded – the Child EMEGs. Exceeding a Child EMEG does not necessarily mean that adverse health effects will occur but indicates that further evaluation is needed. Milk concentrations may be overestimated because the serum data is not limited to lactating women. This analysis is limited by the paucity of adequate data to fully characterize partitioning of PFAS into breastmilk. As breast milk may be the only source of hydration for the first months of life for many infants, a better understanding of environmental chemical transfer to – and concentrations in – an exceptional source of infant nutrition is needed.

Keyword:PFAS, children, breast milk

1052382

A Systematic Review of The Impact of Commercial Aircraft Activity on Air Quality Near Airports

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Abstract: Studies have shown that airport activity can adversely impact air quality, and could therefore affect the health of people living close to airports. In the U.S., approximately 2% of the population (5 million people) live within 500 m of an airport runway and about 95% of the population lives within 30 mi of an airport. This systematic review was conducted to identify peer reviewed literature published in the past 20 years on air quality within 20 km (12.4 mi) of commercial airports, and assess the quality of the studies. The literature search strategy focused on jet engine aircraft activity at commercial airports, thus excluding activity from ground support equipment and piston engine general aviation aircraft. Ambient air concentrations of pollutants (excluding lead) from both monitoring and dispersion modeling were considered on-topic, while regional and global modeling was considered out of scope. Three databases (PubMed, Web of Science, and Google Scholar) were searched using three sets of keywords related to emissions, airports, and measurements. The results were de-duplicated, resulting in a pool of over 3,000 articles which were screened using a combination of supervised machine learning and manual screening techniques. First, the supervised clustering within the program DoCTER (www.icf-docter.com) identified approximately 600 potentially on-topic articles. The performance of the model was confirmed through a 97 percent recall rate of 35 positive seed articles. The tool LitStream (www.icf-litstream.com) was then used for the remaining steps, including manual title/abstract screening and full-text screening to positively identify on-topic articles, as well as for the qualitative extraction of information and data quality review for seventy on-topic references. These studies consistently showed that ultrafine particulate matter (UFP) is elevated in and around airports. Furthermore, many studies show elevated levels of particulate matter under 2.5 microns in diameter (PM 2.5), black carbon, criteria pollutants (PM2.5, PM10, O3, NO2, and CO), and

polycyclic aromatic hydrocarbons as well. More research is needed linking particle size distributions to specific airport activities, and proximity to airports, characterizing relationships between different pollutants, evaluating long-term impacts, and improving our understanding of health effects.

Keyword:air quality, fine particlate matter, other (specify below), aircraft

1039547

Predicting Within-City Spatial Variations in Outdoor Ultrafine Particle and Black Carbon Concentrations in Bucaramanga, Columbia: A Hybrid Approach using Open Source Geographic Data and Digital Images

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Abstract: Outdoor ultrafine particles (UFP; <100 nm) and black carbon (BC) vary greatly within cities and may have adverse impacts on human health such as cardiovascular mortality and brain tumour incidence. Traditional regression methods depend on extensive, curated geospatial information system databases, leading to their widespread use in the data-rich settings of major North American and European cities. This has also resulted in a disparity wherein little is known about local air pollution in the data-sparse settings of low- and middle- income countries. In this study, we used a hybrid approach that exploited unconventional data streams in order to develop new models to estimate within-city spatial variations in outdoor UFP and BC concentrations across Bucaramanga, Colombia. We conducted a large-scale mobile monitoring campaign over twenty days in 2019. UFP and BC concentrations were aggregated over 100m road segments and the data were split into training, validation, and test sets (70-15-15). Regression models were trained on land use data and combined with predictions from Convolutional Neural Networks (CNN) trained to predict UFP/BC concentrations using satellite and street-level images. Combined models were developed by combining predictions from the LUR and CNN models. After training in the training and validation sets, predictions were generated in the test set and compared to measured values. As a sensitivity analysis, the data were split by latitude into 10-folds, all models were trained on 9 of the folds and then evaluated in the 10th fold. This was repeated for all 10 folds. The combined UFP model (R2=0.54) outperformed the CNN (R2=0.47) and land use regression (LUR) models (R2=0.47) on their own. Similarly, the combined BC model also outperformed the CNN and LUR BC models (R2 = 0.51 vs 0.43 and 0.45 respectively). Spatial variations in model performance were more stable for the CNN and combined models compared to the LUR models suggesting that the combined approach may be less likely to contribute to differential exposure measurement error in epidemiological studies. Estimates from these models can then be applied to population-based cohorts in order to evaluate population health risks. Additionally, our findings demonstrated that satellite and street-level images can be combined with a traditional LUR modelling approach to improve predictions of within-city spatial variations in outdoor UFP and BC concentrations.

Keyword:air pollutants, artificial intelligence (AI), exposure models

1037050

How comparable are the direct and indirect measurements of urinary bisphenol A concentrations?

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Abstract: Background: Bisphenol A (BPA) is typically measured in urine using an indirect method that involves enzymatic deconjugation and extraction. In contrast, the direct method measures free and conjugated BPA concurrently and sums them to estimate urinary BPA concentrations. Statistical comparison of total BPA results using the direct and indirect methods is necessary to accurately interpret biomonitoring data for risk assessments. Objectives: To compare urinary BPA concentrations estimated from the indirect and direct methods in duplicate first trimester urine samples collected from1,897 pregnant women. Methods: For the indirect method, we measured urinary BPA concentrations using GC-MS/MS. For the direct method, we summed free and conjugated BPA concentrations measured using LC-MS/MS. We evaluated deviation between the two methods using the Bland-Altman formula approach in the total sample and when stratified 1) by specific gravity and 2) at the limit of quantification (LOQ). Results: Median urinary BPA concentrations for the direct and indirect methods were 0.89 BPA μg equivalents/L and 0.81 μg/L respectively. Concentrations from the direct method were, on average, 8.6% (95% CI: 6.7%, 10.5%) higher than the indirect method based on the Bland-Altman formula. The percent differences between the two methods was 20.3% in urines with specific gravities ≥1.02 (n= 528,28%). In values below the LOQ (n= 663, 35%), we observed smaller average percent deviation (4.8%) between the two methods but wider limits of agreement due to large percentage differences when one value is above and the other is below the limit of detection. Conclusions: Results from this study provide the largest statistically rigorous comparison of the direct and indirect methods of BPA measurement. The observed difference in urinary BPA concentrations obtained with the indirect and direct methods is unlikely to alter the interpretation of health outcome data.

Keyword:biomonitoring, epidemiology, other (specify below), bisphenol A

1040156

Analyzing the Effects of Emerging Environmental Exposures on Human Health Using the Comparative Toxicogenomics Database

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Abstract: The freely available Comparative Toxicogenomics Database (CTD; http://ctdbase.org) is a powerful, multifaceted resource that integrates and harmonizes chemical, gene, phenotype, anatomy, and disease relationships to advance our understanding about environmental exposures on human health and their underlying mechanisms. Data associations are manually curated in four primary content areas: chemical-gene interactions, chemical-disease and gene-disease associations, chemical-induced phenotypes with anatomical descriptions, and exposure details. These content areas are integrated with external datasets containing Gene Ontology terms and pathway data to provide a knowledgebase of over 46 million toxicogenomic relationships. The exposure module details relationships between chemical stressors and phenotype and disease outcomes, including exposures to emerging environmental contaminants (e.g., perfluorinated compounds, air pollutants, vaping aerosols). These data can be explored with user-friendly query and analytical tools to promote hypothesis development connecting chemicals/drugs, genes/proteins, diseases/phenotypes, anatomy/physiology, taxa, functional annotations, pathways, and population-based exposure events. In addition, they can generate predictive adverse outcome pathways (AOPs) and link molecular initiating events to key events and population-level health outcomes. Here we provide examples of how CTD can be used to fill knowledge gaps between emerging environmental exposures and adverse human health outcomes. 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 emerging environmental exposures affect human health.

Keyword:multiple stressors, analytical methods, environmental health, database

1042101

Perfluoroalkyl acids in fish from Baltic Sea sub-basins – Dietary exposure and risk assessment

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Abstract: Occurrence and distribution of perfluoroalkyl acids (PFAAs), a sub-category of per- and polyfluoroalkyl substances (PFAS), is widespread in the environment. Fish meat is a major pathway via which humans are exposed to PFAAs. In a monitoring study conducted in Finland, levels of selected PFAAs were determined from fish caught from Finnish Baltic Sea sub-basins and PFAA dietary exposure of Finnish adult population from Baltic fish was assessed. Perfluorooctane sulfonate (PFOS) was the most abundant compound that was detected in all fish species, comprising 46-100% of the ∑PFAA concentration. Median ΣPFAS-4 (PFOA, PFNA, PFHxS, PFOS) concentrations varied from 1.0 ng/g wet weight (ww) in roach to 19.8 ng/g ww in smelt. Results based on PFAA concentration in fish and calculated PFAA intake were compared with new safety threshold (tolerable weekly intake (TWI) of 4.4 ng/kg body weight (bw) per week) set for the ∑PFAS-4 by European Food Safety Authority. Moderate consumption of most Baltic fishes (200 g/week, bw: 70 kg) is found to result in an exceedance of TWI for ∑PFAS-4. However, it is emphasized that actual average consumption of wild-caught fish in Finland is 73 g/week– estimated to be in the

range of 4.4 g/week (whitefish) to 7.5 g/week (herring) in 2019 – is less for most Finnish people. Overall, the study findings call for continued monitoring of PFAS in fish and periodic assessment of health benefits versus risk of PFAS exposure via fish diet for Finnish population.

Keyword:environmental health, PFAS, other (specify below), Fish consumption, Dietary exposure

1042791

Glyphosate and AMPA exposure in relation to markers of biological aging in an adult population-based study

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Abstract:BACKGROUND/AIM: Glyphosate is a broad-spectrum, non-selective herbicide used in agricultural formulations worldwide. Both glyphosate and its main metabolite aminomethylphosphonic acid (AMPA) are persistent in the environment, posing a potential long-term threat to human health. Studies showed associations between glyphosate or AMPA exposure and several adverse cellular processes, including metabolic alterations and oxidative stress. However, the association of glyphosate and/or AMPA exposure and biomarkers of aging such as mitochondrial DNA (mtDNA) content and leukocyte telomere length is poorly investigated. Therefore, we determined the association between glyphosate and AMPA exposure and biomarkers of biological aging. METHODS: We examined glyphosate and AMPA exposure, mtDNA content and leukocyte telomere length in 181 adults, included in the third cycle of the Flemish Environment and Health Study (FLEHSIII). DNA was isolated from leukocytes and the relative mtDNA content and telomere length were determined using qPCR. Urinary glyphosate and AMPA concentrations were measured by Gas Chromatography-Tandem Mass Spectrometry (GC-MS-MS). We used multiple linear regression models to associate mtDNA content and leukocyte telomere length with glyphosate or AMPA exposure while adjusting for confounding variables. The association of glyphosate exposure and telomere length was further explored in vitro using multipotent mesenchymal stem cells (i.e. dental pulp stem cells, DPSC). RESULTS: A doubling in urinary AMPA concentration was associated with 2.95% (95% CI: 0.07 to 5.92; p = 0.045) longer leukocyte telomere length, while no association was observed with urinary glyphosate concentration. No association between mtDNA content and urinary glyphosate nor AMPA levels was observed. An in vitro experiment showed that a 200 ng/µL increase of glyphosate concentration in DPSC cultures was associated with 2.28% (95% CI: -4.19 to -0.33; p = 0.02) shorter telomere length. CONCLUSIONS: We found evidence of an association between glyphosate and AMPA exposure and leukocyte telomere length.

Keyword:biomarkers, environmental health, pesticides

1042947

Connecting communities: Mapping PFAS contamination in the United States

D. Salvatore[1], K. Mok[1], M. Fitzstevens[2], J. Lytel-Sternberg[3], P. Brown[4], A. Cordner[5], L. Schaider[2], A. Goho[2], E. Haugsjaa[2]; [1]Northeastern University PFAS Project Lab, [2]Silent Spring Institute, [3]Harvard T.H. Chan School of Public Health, [4]Northeastern University, [5]Whitman College

Abstract: Background: Community knowledge of toxic pollution is often limited by the inaccessibility of information about the health, environmental, and economic impacts that residents face. Per- and polyfluoroalkyl substances (PFAS) are a large class of highly persistent chemicals used in industrial and commercial products. Exposure to PFAS has been linked to numerous health effects, including lowered immune responses, testicular and kidney cancer, and reproductive effects. Understanding the extent of PFAS contamination is challenging because of the wide range of potential sources of PFAS exposure, breadth of the chemical class, and inadequate federal regulation. Methods: This poster presents an interactive ArcGIS map maintained by PFAS Project Lab that integrates multiple sources of data on PFAS contamination with demographic and industry data and can enable quantitative analysis of PFAS contamination proximity. The publicly available, interactive map displays all known contaminated sites in the United States. Each of the 1,300+ sites can be expanded to display information such as contamination levels, nature of sources, and site documents. Additionally, community groups that focus on PFAS are mapped to connect residents with local organizations. Findings: Since PFAS sampling and enforcement efforts vary by state, we categorize states by their actions on PFAS (e.g., regulatory limits and statewide testing). This distinguishes states that have many contaminated sites due to extensive testing from states with few known contaminated sites due to limited monitoring. Additionally, spatial analysis in ArcGIS enables us to quantitatively analyze disparities that exist in PFAS exposure. Low-income and minority populations are at higher risk of exposure due to historic housing discrimination and inequitable enforcement of environmental regulations. Conclusion: Our analysis enables quantitative assessment of PFAS contamination and the identification of disproportionately impacted populations, with the goal of informing the public of these threats and advocating for more stringent regulations. While much PFAS contamination has yet to be identified, this map makes current knowledge of contamination publicly available to build community awareness and resiliency to these toxic chemicals. This mapping effort extends our previous work on a multisector alliance approach to understand the broad range of stakeholders involved in environmental health advocacy and regulatory change.

Keyword:PFAS, environmental health, geospatial analysis/GIS

1042730

Per- and Polyfluoroalkyl Substances (PFAS) in Breast Milk: Concerning Trends for Current-Use PFAS

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Abstract: This is the first study in the last 15 years to analyze per- and polyfluoroalkyl substances (PFAS) in breast milk collected from mothers (n = 50) in the United States and our findings indicate that both legacy and current-use PFAS now contaminate breast milk, exposing nursing infants. Breast milk was analyzed for 39 PFAS, including 9 short-chain and 30 long-chain com-pounds, and 16 of these PFAS were detected in 4-100% of the samples. The PFAS concentra-tion in breast milk ranged from 103 to 1850 pg/mL with a median concentration of 121 pg/mL. Perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were the most abundant PFAS in these samples (medians 30.4 and 13.9 pg/mL, respectively). Several short-chain PFAS, including perfluoro-n-hexanoic acid (PFHxA, C6) and perfluoro-n-heptanoic acid (PFHpA, C7), were detected in almost all of the samples with median concentrations of 9.69 and 6.10 pg/mL, respectively. Analysis of the available breast milk PFAS data from around the world over the period of 1996-2019 showed that while the levels of the phased-out PFOS and PFOA have been declining with halving times of 8.1 and 17 years, respectively, the detection frequencies of current-use short-chain PFAS have been increasing with a doubling time of 4.1 years.

Keyword:breast milk, PFAS, environmental health

1000675
Decision Support Tool Overview
D. Vallero; U.S. Environmental Protection Agency/Center for Computational Toxicology and Exposure

Abstract: Several decision tools are being developed, enhanced and adapted to address multi-route and multi-pathway, aggregate exposures. In particular, this presentation will describe EPA's potential application of these tools to chemicals of concerns.

1000675
Conceptual Exposure Scientific Workflows
E. Cohen Hubal; U.S. EPA, ORD, Center for Public Health and Environmental Assessment

Abstract: Summarizes the progress toward EPA's exposure scientific workflow to address specific partner defined decision context.

1000675
Product Use Scheduler
S. Brady; Oak Ridge Associated Universities

Abstract: The PUS provides schedules of usage of consumer products based on behavior diaries defining general behaviors for different demographic groups. The inputs to the module include year-long daily activity patterns, product type, and generated human characteristics provided from RPGen, and are used to generate a set of activity patterns that specifies products used on each day of the year by individuals. The resulting output is a longitudinal

data set that contains predictions based on demographic characteristics, product use and exposure, macro behaviors, and seasonality for individuals.

1000675
Residential Population Generator
A. East; Oak Ridge Associated Universities

Abstract:RPGen creates synthetic populations with demographic, residential, and physiological characteristics for use in intra-individual probabilistic models of exposure and external and internal doses. By appending demographic profiles with housing characteristics that determine exposure, RPGen allows modelers to simulate data-driven populations and identify those potentially vulnerable to chemical exposures.

1000675
Source-to-Dose Module (S2D)
H. Fisher; Oak Ridge Institutes for Science and Education

Abstract: This module takes in a simulated population and product use diary, typically from PUS, and calculates estimated exposures over the course of a year. Recent additions to Source to Dose include sections for calculating exposure due to diet and articles.

1000675
Bridging the information gap of exposure model parameterization by coupling disparate data sources
D. Dawson; U.S. Environmental Protection Agency

Abstract:A major challenge of exposure modeling is parameterizing the underlying algorithms such that exposure estimates are reliable. In the case of modeling exposure to chemicals from consumer product use, scarce and often decades-old data is often used to inform patterns of product use. In recent years, the large-scale, automated collection of consumer product purchase data has moved the analysis of purchase patterns into the realm of “Big Data”, allowing for tantalizing insight into potential patterns of exposure. However, consumer purchase behaviors are not directly related to product use patterns. In addition, product use data still relies on survey and diary techniques that are expensive to collect and may not share the same demographic considerations or temporal and spatial scales as consumer purchase datasets. To bridge this gap, modeling frameworks must be created to couple disparate purchase datasets to translate consumer purchase information to consumer use predictions. In this case study, we will develop such a framework to couple a large dataset detailing consumer product purchases in American households (Nielson Company) to a similarly large, but focused consumer product use dataset detailing consumer product use by women (NIH Sister’s Study). Using the cross-sectional modeling platform SHEDS-HT (The Stochastic Human Exposure Dose Simulator) and a subset of products and chemicals, we will then compare projected chemical exposure based on either model or survey-data derived model parameterization. The modeling workflow developed here will serve as a useful framework for coupling other consumer use and consumer purchase datasets.

1000675
1,4-Dioxane Case

D. Dawson; U.S. Environmental Protection Agency

Abstract: Using SHEDS-HT to model human and down-the-drain exposure to 1,4-Dioxane (1-4D) to both water consumption and product use, it is being parameterized and validated using publicly available data.

1001838
Measuring PM2.5 from cannabis use in public places
S. Schick; University of California, San Francisco

Abstract: This study measured PM2.5 concentrations from cannabis use in a variety of public places in the San Francisco Bay Area. The locations included the smoking lounges of cannabis dispensaries as well as public concerts and street fairs, even where smoking was not legal. We found that smoking cannabis can create PM2.5 concentrations over 1,000 micrograms per cubic meter indoors and over 300 micrograms per cubic meter outdoors. The data suggest that using cannabis can create significant air pollution and that exposures may lead to negative health effects.

1001838
Secondhand exposure to vaping marijuana: emissions, concentrations, decay rates, and exposures
L. Wallace; Stanford University

Abstract: This study used research-grade monitors (2 SidePaks, 2 Piezobalances) collocated with 4 low-cost monitors in 4 rooms of a home (kitchen, living room, guest room, and small office) to measure the PM2.5 aerosol produced by vaping commercially available marijuana liquid using commercially available vape pens. Concentrations were monitored for approximately 2 hours in 2-minute samples after good mixing throughout the house was achieved (typically 45 minutes after the initial puff). This provided information on the source strength (mg/puff) using methods described in previous publications. Concurrently, CO concentrations were elevated in all the rooms by walking with a cylinder releasing the gas at a known rate, and the CO decay rate was analyzed to determine the air exchange rate. The decay of particles was analyzed to determine the slope (air exchange rate a + deposition rate k), and the particle deposition rate k was determined by subtracting a from the decay rate. These parameters allowed a model to be built predicting likely exposures in homes with different volumes, air exchange rates, and vaping frequency.

1001838
Exposure to fine particles from secondhand marijuana smoke in a home
W. Ott; Stanford University

Abstract: This study measured PM2.5 concentrations using controlled experiments in an occupied home. PM2.5 monitors were placed in 8 different rooms of the home. Except for one room, the interior doors of the rooms were open, while the exterior windows of the rooms were closed. A marijuana joint was machine-smoked in the downstairs family room. The results indicated the PM2.5 concentration time series in all the rooms with open doors were similar, reaching a maximum of 130-150 micrograms per cubic meter and exhibiting similar

particle decay rates, while the room with its door closed reached 30 micrograms per cubic meter, suggesting considerable penetration of PM2.5 into the room with the closed door.

988065
Moderator
M. Chan; Harvard T.H. Chan School of Public Health

Abstract: Marissa Chan, a graduate student at Harvard T.H. Chan School of Public Health, will moderate this symposium.

988065
Environmental Justice Dimension of Urban Oil and Gas Drilling in Los Angeles County
M. Chan; Harvard T.H. Chan School of Public Health

Abstract: Social and environmental stressors are combined in low income communities and communities of color. The resulting cumulative burden contributes to disparities in well-documented health inequalities reported among environmental justice communities. We examined the location of active oil and gas production on-shore wells in Los Angeles County and find community facing more environmental hazards are also more likely to be near an active oil operations. The work can inform the reexamination of policies and frameworks which may reduce exposure from oil and gas development on an individual or state-wide level.

988065
Potential Demographic Differences in Chemical Exposure Derived from Purchasing and Consumer Ingredient Data Streams
K. Isaacs; U.S. EPA

Abstract: This talk will present an analysis of a combined dataset of consumer product ingredient and household purchasing data, with the goal of understanding demographic differences in potential exposures, especially in under-represented or sensitive populations. Purchasing and ingredient data were combined to characterize chemicals being introduced into 60,000 households possessing demographic descriptors (including household income, family size, age, education level, and race of female head of household). Potential differences in chemical exposure arising in different demographics from 1) purchase or use of different types of products and 2) varying formulations (i.e., brand choice) were assessed.

988065
Personal Care Product Use among Black, Latina, and Vietnamese Women: Implications for Chemical Exposures
P. Johnson; California Department of Public Health

Abstract: Using a community-based participatory process, we surveyed a multi-ethnic sample of over 300 women in unique California communities about their personal care product use and found distinct patterns by race/ethnicity. We surveyed stores where women in these communities shop and documented ingredients of concern for endocrine disruption and

cancer listed on product labels. Using a hybrid targeted/nontargeted analysis of 31 products, we found additional chemicals of concern not identified on product labels.

988065
Personal care product use among diverse women in California: Taking Stock Study
R. Dodson; Silent Spring Institute

Abstract: We sought to document consumer product use among a diverse group of women living in California. Through a community-academic partnership, we surveyed women about their use of cosmetic, hair, feminine care, and leave-on and rinse-off personal care products. We compared type and frequency of product use among Black, Hispanic/Latinx, Asian, and White women. We also summarized use of scented products and reasons women select consumer products

988065
Examining racial/ethnic and socioeconomic disparities in feminine care product use through an intersectional framework
A. Zota; George Washington University Milken School of Public Health

Abstract: The environmental injustice of beauty framework asserts that elevated exposures to beauty product chemicals in women of color are in part attributable to the influence of intersectional systems of oppression (i.e., racism, sexism, classism) on beauty practices and beauty norms. However, few studies have examined personal care product use at different intersections of class and race/ethnicity. We will use data from two different studies on diverse groups of reproductive-aged women to examine the joint impacts of race and class on feminine care product use

988065
A Pilot Study Measurements Reality Check on Predicting Consumer Product Chemical Exposures
T. Buckley; U.S. EPA / ORD / CCTE

Abstract: We conducted an intensive pilot measurements study to see how well consumer product chemical exposures could be predicted from questionnaire data that was derived from the NIEHS Sisters Study. Nine women were followed over 10 days using a combination of questionnaire, daily diary, GPS, urinary biomarkers, and environmental monitoring (dust, air, diet). We examine the within and between person coherence of questionnaire data to predict consumer product chemical exposure as compared to urinary biomarkers.

988065
Time Trends in Racial/Ethnic and Acculturation Disparities in Endocrine Disrupting Chemicals
Z. Wang; Harvard T.H. Chan School of Public Health

Abstract: Using data from NHANES, we will evaluate time trends in the percent difference in chemical concentrations for racial/ethnic groups and for acculturation measures. This study will allow us to understand whether disparities are increasing or sustained over time in recent years, accounting key sociodemographic factors that could help to understand environmental

health disparities.

995570
Use of biomarkers of exposure to assess health impact of e-cigarette use
M. Goniewicz; Roswell Park Comprehensive Cancer Center

Abstract:E-cigarette aerosol is a significant source of exposure to nicotine and several toxic compounds. Characterizing human exposure to constituents in e-cigarette aerosol is important for public health efforts aimed at reducing exposure to these chemicals. E-cigarette exposure can be assessed through biomonitoring, i.e., by measuring the concentration of a toxicant or its metabolites in human physiological fluids. Biomarkers, ideally unique to a toxic mixture such as e-cigarette aerosols, are useful for exposure assessment and for source apportionment. This presentation will review biomarker studies that have demonstrated internal exposure to toxic constituents due to e-cigarette use. Presentation will also discuss how observed levels of biomarkers can be used to assess relative harm of e-cigarettes compared to tobacco cigarettes.

995570
On the correlation of flavor ingredients in ECIG liquids to toxicants in the aerosols
A. El Hellani; American University of Beirut

Abstract: Flavors in electronic cigarette (ECIG) liquids may increase ECIG aerosol toxicity via intact distillation or chemical transformation. For this report, we performed a meta-analysis of the literature to categorize the compounds found in flavored ECIG liquids into a few chemical classes and to predict their possible chemical transformations upon ECIG liquid aerosolization. This analysis allowed us to propose specific correlations between flavoring chemicals and aerosol toxicants. The systematic literature review included a total of 11 articles. The subsequent prediction of chemical transformations of these functional groups highlighted the possible correlation of flavor compounds to aerosol toxicants. This work will be the basis to develop a kinetic model that can predict toxicant formation upon ECIG activation.

995570
Chemistry insights into tobacco product flavorants: e-liquid reactivity and synthetic coolants
H. Erythropel; Yale University

Abstract: This presentation will focus specifically on two areas of concern for flavored e-liquids: the potential for flavorant molecules to react with the solvents propylene glycol and glycerol to form new chemical entities, with separate physical and toxicological properties. The other area of concern are synthetic coolants that have cooling properties similar to menthol, yet lack its distinct odor. In addition, very little is known about the inhalation toxicology of such synthetic coolants.

995570
Non-targeted characterization and identification of potential toxicants in e-cigarette aerosols

M. Tehrani; Johns Hopkins University

Abstract: Aerosols that are inhaled by e-cigarette (e-cig) users are chemically complex and have been reported to contain a variety of known toxicants. This study aimed to identify previously unknown organic chemicals, including transformation products that are formed during the vaping process, in e-cigarette liquids and aerosols using a non-targeted approach. Organic toxicants and metal species were further investigated using quantitative methods. A selection of popular commercial e-cig liquid and aerosol samples were analyzed for both organic and inorganic constituents using mass spectrometry techniques. Chemical fingerprinting analyses indicated that e-liquids before vaping contained more lipid-like compounds, while less saturated compounds were generated by vaping. The presence of eleven organic chemicals of potential health concern and arsenic species were confirmed in commercial products using reference standards. These results demonstrate the potential of chemical fingerprinting approaches coupled with quantitative analysis in characterizing e-cig samples.

EXPOSURE SUSCEPTIBILITY

1054707

Association between acute exposure to smoke PM2.5 and cardiovascular emergency department visits in California in 2016

B. Vu, R. D'Souza, C. Howard, Y. Liu, D. Zhang; Emory University

Abstract: Background: There have been an increase in wildfire activity in the Western United States in recent years resulting in the release of vast amounts of smoke PM2.5, particulate matter with an aerodynamic diameter of 2.5um or less. Ambient PM2.5 have been shown to adversely affect health outcomes, yet smoke PM2.5 have been less studied due to limited data sources with good spatial and temporal resolution for epidemiologic studies. Objective: This study investigates the association between acute exposure to smoke PM2.5 and emergency department (ED) visits for cardiovascular outcomes including total cardiovascular diseases (CVD), stroke and myocardial infarction (MI) in California by districts in 2016. Methods: Daily smoke PM2.5 was calculated at 15km x 15km resolution using a Hazard Mapping System (HMS) flag and aggregated to the zip code level. We controlled for prescribe burns and active fire spots using binary indicators created from MODIS C6 Active Fire Products. We also controlled for meteorological conditions including daily maximum temperature and dewpoint. Daily counts of California ED visits in 2016 for CVD, stroke, and MI were collected at the district level. We utilized a case-crossover approach to fit conditional logistic regression to estimate the association between smoke PM2.5 and cardiovascular outcomes. Results: In total, we had 30,230 CVD cases, 2,631 stroke cases, and 1,731 MI cases. Per 1 ug/m3 increase in smoke PM2.5, we observed a statistically significant association for CVD (OR: 1.29), stroke (OR: 1.25), and MI (OR: 1.30). Discussion: Results from this study indicates that acute exposure to smoke PM2.5 dramatically increases the odds of ED visits for cardiovascular outcomes and broadens the body of literature on the impact of smoke PM2.5 exposure.

Keyword:case-crossover, fine particlate matter, other (specify below), cardiovascular diseases

1054659

Identification of Thirdhand Smoke Chemical Constituents in Settled House Dust Using a Non-Targeted Analytic Technique

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Abstract: Third hand smoke (THS) is the persistent and toxic residue from tobacco smoke on indoor surfaces and dust, and reemitted in air. These residues can also form secondary toxic pollutants by reacting with other compounds in the environment. A comprehensive understanding of the chemical constituents of THS is necessary to assess the risks of long term human exposure and to establish reliable tracers to detect the presence of THS. The objective of this study was to determine compounds in house dust from smokers' homes through non-targeted analysis. Non-targeted analysis of settled house dust samples from 10 smokers' homes and 9 non-smokers homes was performed using two-dimensional gas chromatography coupled to time-of-flight mass spectrometry (GC × GC-TOF MS). A set of compounds that were either only present in dust from smokers' homes or more abundant in the dust based on an average chromatographic peak abundance five times greater in smokers' homes than non-smokers' homes were termed qualified compounds. Of these, those compounds with a similarity score >700, with the top three ions in NIST library present, and with a high mass spectral matching with the NIST mass spectral library were termed tentatively identified. These compounds were confirmed using authentic standards, if available. The differences in concentration (average peak area/ gram of dust) and dust loading (average peak area/ m2 vacuumed) of these compounds were compared between smoker and nonsmoker homes. Confirmed compounds were compared to literature on the chemical components of tobacco smoke. We identified 140 were qualified compounds, and of these a total of 42 compounds were tentatively identified from the house dust samples. Of these 42 compounds, 16 of these compounds were only found in dust from smokers' homes and the remaining 26 were more abundant in smokers' homes compared to nonsmokers' homes. Of these, two compounds found only in smokers' homes are already used as tracers for tobacco smoke (nicotine, 3-ethenyl pyridine). Tris (2-chloroethyl) phosphate and propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester were found in all smoker's homes and no non-smokers' homes, making these potential tracers of THS. We identified potential tracers and chemical components of THS through comprehensive non-targeted analysis, which could be used in future studies to characterize exposure and risk.

Keyword:environmental tobacco smoke (ETS), public health, analytical methods

1054676

Particulate Matter Index in a Semi-Industrial Area of Lagos State, Nigeria

T. FINGESI, O. OGUNSEYE; University of Arizona

Abstract: Outdoor air in developing countries is polluted with a variety of noxious agents that can result in increased morbidity and mortality, through short- and long-term exposures. This feasibility study is a mini version of a full-scale study aimed at determining the ambient levels of particulate matter in order to map out air pollution hotspots in selected communities across the Western region of Nigeria. About fifty percent of Nigeria's industrial activities including 300 industries in 12 industrial estates are located in Lagos state and the sampling location being one of them has a mix of industrial and residential buildings. This study assessed the ambient levels of PM2.5 and PM10 by evaluating the air quality index in selected sampling locations in Surulere industrial area of Lagos state, Nigeria. Three sampling locations in the study with known coordinates were monitored for ambient levels of the pollutant using 'MET ONE airborne particulate counter' –a mobile handheld instrument specific to particulate count. The eight-hour average for three consecutive days of the week was recorded. Descriptive and inferential statistics were employed for data analysis using the SPSS version 21. Results across the three sampling locations show that PM10 level (0 – 41µm-3) was satisfactory; while PM2.5 (12 – 1095µm-3) at mean and maximum levels exceeded USEPA AQI satisfactory levels with a notable particle count of 1095µm-3. It was evident from the onsite observations that the relatively large-scale manufacturing in the study area required regular transporting of raw materials and finished goods with the use of heavy-duty trucks that inadvertently pollute the environment with smog and soot. However, the noticeable lack of accessible air quality monitoring data makes it difficult to understand the severity of the problem as well as benchmark trends. The evidence from this study therefore suggests that continuous exposure of residents and workers in the study area to higher than permissible limits of fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller could bear significant risk on human health especially the vulnerable groups and the environment. Thus, it is pertinent to develop grassroots-networks for a continuous pollution exposure assessment especially in visibly polluted areas in order to recommend safer measures, promote public participation and government input towards a healthier air quality.

Keyword:air quality, fine particlate matter, community

1054690

Determining the exposure factors of children's products by gender, age, and season.

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Abstract: Children's products contain various hazardous chemicals, which may unintentionally be exposed to children due to their behavioral characteristics. Children are more vulnerable to hazardous chemicals than adults. It was necessary to determine the usage pattern of children's products to prevent adverse health effects. The use rate and frequency of 59 children's products by gender, age, and season were investigated by national representative

survey. A total of 20,000 participants (10,152 boys and 9,848 girls) from 0 to 12 years old were included and the questionnaires were completed by their parents. The 59 products were classified into 5 categories: infant product (13), toy (13), daily product (10), sporting goods/ sports equipment (8), and stationary (15). Use rates were different by gender, age, and season. The use rates of audio toys, included in toy category, showed the greatest difference by age group with 84.6% for infants (0-2 years old) and 7.0% for higher grade kids (10-12 years old). In the sporting goods/ sports equipment category, the use rate of gloves was significantly higher in boys than in girls, 20.3% for boys and 4.8% for girls. In the infant product category, tooth tissue was used more in winter than in summer. Average of use frequency was 2.3±1.3, 0.5±0.4, 1.7±1.2, 0.3±0.1, and 0.4±0.1 events/day in infant product group, toy group, daily product group, sporting goods/ sports equipment group, and stationary group, respectively. For accurate exposure assessment of children's products, the exposure factor of main user population for each children's product would be considered. These exposure factors for children's products are necessary for providing essential data in future researches and setting safety guidelines for children's products.

Keyword:children, exposure factors, risk assessment

1054401

Sex/gender assessment of lysmeral exposure of children and adolescents living in Germany

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Abstract: Comprehensive consideration of the biological and social diversities of sex and gender as well as their interdependencies is mostly missing in human biomonitoring (HBM) studies. Although closing gender inequalities remains one of the key challenges in environmental health studies and policy, the sex/gender assessments are mostly limited to a binary understanding of sex along with the inconsistent, interchangeable use of sex and gender terms. Differences in lysmeral exposure, a compound commonly used as a perfume in cosmetic preparations and laundry powders, based on sex as a binary variable were reported previously (Murawski et al., 2020). The aim of this study was the analysis of these differences incorporating several sex/gender dimensions based on the multidimensional sex/gender concept developed by the collaborative research project INGER considering its applicability and benefits. Lysmeral metabolites concentrations were determined in urine samples of 2294 children and adolescents aged 3 to 17 years from the population-representative German Environmental Survey for Children and Adolescents (2014 -2017) (GerES V). A total of 140 variables relating to different dimensions of sex/gender, intersectionality and embodiment as well as the exposure with lysmeral-containing products were identified and included into analysis using multivariate statistical models. Besides showing high dependencies to the variables "sex" and "age", exposure variables proved to have the highest explanatory value, with use of various cosmetics and fabric conditioner as main factors. Mediating effects of behavior associated with societal gender expectations were observed, as the use of cosmetics correlated highly with lysmeral metabolites concentrations in girls between 6 and 17 years, with the strongest effect in adolescents between 14 and 17 years old. In the youngest age group (3-5 years) boys showed higher concentration of the

metabolite TBBA compared to girls of the same age but only if TBBA urine concentrations were not normalized on creatinine. Our study offers the first case of comprehensive sex/gender assessment on existing HBM data. Although the explanatory value of additional sex/gender variables on exposure assessment with lysmeral was small, the better understanding of exposure context adds a high value for the targeted design of health prevention measures and policy advice.

Keyword:biomonitoring, children, other (specify below), sex/gender

1054385

Para-occupational determinants of cholinesterase inhibition and pesticide exposure among children and adolescents in agricultural settings: cohabitation with floricultural workers and residential proximity to crops.

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Abstract:INTRODUCTION: People living with agricultural workers and those living near agriculture have increased potential for pesticide exposures. Organophosphates (OP) are frequently used insecticides in floriculture, and they inhibit the enzymatic activity of acetylcholinesterase. This study characterized the associations of 2 important para-occupational exposures, cohabitation with floricultural workers and residential proximity to greenhouse floriculture, with biomarkers of pesticide exposure. METHODS: We included data of 623 participants collected during 3 examinations between 2008 and 2016 (4-9y of age in 2008) living in Ecuador (ESPINA study). Participants did not work in agriculture. We characterized associations of a) Cohabitation with floricultural workers and b) Residential proximity to floricultural crops with AChE activity (whole blood) and metabolites of OP pesticides (urine). We calculated distances between homes and greenhouses, and areas of greenhouses within various buffer zones around homes. Generalized linear mixed models estimated longitudinal and cross-sectional associations, adjusting for hemoglobin, creatinine and other demographic and anthropometric covariates. RESULTS: The pooled mean (SD) of AChE activity was 3.58 U/mL (0.60). The median (25th-75th %tile) residential distance to crops was 334 m (123, 648) and crop area within 500 m of homes (non-zero values only) was 18,482 m2 (7115, 61,841). Residential proximity to greenhouse crops was associated with lower AChE activity among children living within 275 m of crops (difference per 100 m of proximity [95% CI] = −0.06 U/mL [95%CI: -0.10, -0.01]). Similarly, residential proximity within 300m of crops was associated with higher urinary concentrations of para-nitrophenol (PNP), a metabolite of parathion (% difference per 100m of proximity = 8.5% [95%CI: 1.8, 14.7]) and other pesticide metabolites. Cohabitation with one or more floricultural workers was associated with lower AChE activity (-0.09 U/mL (95%CI: -0.14, -0.03). CONCLUSION: Two para-occupational pesticide exposure sources, living within 300m of greenhouse crops and cohabitation with floricultural workers, were associated with lower AChE activity and higher urinary pesticide metabolites in analyses from childhood to adolescence. This also indicates that AChE activity is a sensitive biomarker of OP exposures in population-based studies. Efforts to reduce children's pesticide exposures from para-

occupational sources are necessary.

Keyword:pesticides, children, biomarkers

1054370

Double Disproportionality in Industrial Air Pollution in Canada: Emissions and Exposure

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Abstract: Many industries exhibit disproportionalities in emissions of fine particulate matter (PM2.5) and PM2.5 precursors. Disproportionalities arise when a small number of sources emit a disproportionate amount of pollution compared to other sources with similar characteristics. Disproportionalities in emission patterns are seen in numerous sectors, from carbon emissions in the power sector to criteria pollutant emissions from vehicles. Furthermore, previous research has shown that industries and facilities that emit a disproportionate amount of pollution may be more frequently located in disadvantaged communities, creating a double disproportionality in both emissions and impacts. Identification of emission disproportionalities and their impacts on human health and environmental justice can be beneficial for targeted policy changes to efficiently reduce emissions and environmental harms. To date, this line of inquiry has been mainly explored in the United States and is less frequently studied in other countries. Our study applies the theory of double disproportionality to Canadian industries to identify sectors and facilities that are disproportionate emitters and to assess their impacts on disadvantaged communities. We use data from the National Pollutant Release Inventory (NPRI) to determine which sectors and facilities are the most egregious emitters of PM2.5 and PM2.5 precursors. We find that mining and quarrying, oil and gas extraction, paper manufacturing, and primary metal manufacturing consistently rank among the top emission sectors for PM2.5. Among these sectors, we observe significant disproportionalities in paper manufacturing and primary metal manufacturing, which together consistently represent an average of 33% of total NPRI PM2.5 emissions by weight while only accounting for about 6% of total PM2.5-emitting NPRI facilities. We analyze where disproportionate emitter facilities are located and the demographics of surrounding regions. After selecting facilities that are disproportionate emitters, we also quantify the marginal social cost of PM2.5 emissions from individual facilities by employing the Estimating Air pollution Social Impact Using Regression (EASIUR) model. We present results on the extent to which facilities that are disproportionate emitters contribute to the social cost of air pollution.

Keyword:environmental justice, particulate matter (PM), other (specify below), industrial air pollution

1054455

Exposure to Lead and Other Metals for Pregnant Women in the National Children's Study

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Abstract: Much is known about human exposure to contaminants in residential settings. Existing data gaps, however, point to a need to measure chemicals more comprehensively in environmental media and biological samples, particularly for exposure during pregnancy and early life stages. The National Institutes of Health (NIH), National Institute of Child Health and Human Development (NICHD) National Children's Study (NCS) Vanguard Studies were designed and piloted from 2009 through 2014 to fulfill this research need. We accessed NCS data through the NIH Data and Specimen Hub (DASH) and combined NCS measurement data with its survey instrument information for robust, multi-faceted exposure analysis. Our focus was on lead (Pb) and other metals from maternal blood samples, maternal urine samples, house surface wipe samples, and house dust vacuum samples. For Pb, blood samples ranged from 0.18 to 3.09 ug/dL for pregnant NCS participants (n=426), and creatinine-adjusted urinary Pb concentrations (n=366) ranged from 0.11 to 3.8 µg/g. Pb loadings in surface wipe samples obtained in the mother's homes during pregnancy (n=640) and from areas where the children spent the most time at roughly 6 months of age (n=99) ranged from 0.02 to 71.8 ng/cm2. Vacuum bag dust Pb concentrations (n=208) ranged from 2.3 to 1350 µg/g. Blood and urine results for this group of pregnant women were similar to those observed for females in the general U.S. population in the National Health and Nutrition Examination Survey. Our correlation analyses and linear models examined and estimated relationships for selected metals within and across media in the NCS data. The availability of the residential environmental media and extensive survey data provides for enhanced understanding of important exposure sources and pathways for Pb and other metals during pregnancy and early life.

Keyword:lead (Pb), children, metals

1054546

Comparing Human Health and Freshwater Ecosystem Impacts of Chemicals in Consumer Products

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Abstract: Consumer products contain chemicals associated with adverse human health and ecosystem impacts. However, chemicals that are damaging to human health are not necessarily destructive to freshwater ecosystems (and vice versa), as mechanisms of toxicity and exposure pathways differ between humans and aquatic life. To evaluate the relative ecotoxicological and human health damage of chemicals in consumer products during use phase, high-thoroughput analysis was conducted for 5,500 chemical-product combinations. Population-level usage data was obtained from CPDAT and the Stochastic Human Exposure and Dose Simulation Model (SHEDS-HT), which includes data for 262 chemicals and 181 products. Usage data was extrapolated to the generic USEtox population of 1 billion individuals in a continent. Chemical fate and transport were estimated using USEtox mass-balance modeling. Human health impact was characterized using population-level disability

adjusted life years (DALY), accounting for fate, exposure, and toxicity of chemicals. Similarly, freshwater ecotoxicological impact was estimated by calculating the potentially disappeared fraction of aquatic species (PDF) due to chemical-product usage. PDF was computed using resulting chemical concentrations in freshwater and ecotoxicological concentration-response factors. Total PDF and total DALY were analyzed for each chemical-product combination, from both chemical and product perspectives. Chemicals with the highest human health damage include triethanolamine, hydroquinone, dichloromethane, acrylic acid, and D-Limonene. Chemicals with the highest ecosystem damage include cyfluthrin, 2-Methyl-3(2H)-isothiazolone, ƛ-cyhalothrin, trifluralin, as well as two salts (sodium dichloroisocyanurate and sodium dodecyl sulfate) for which model domain validity is to be further explored. Home maintenance products were the most damaging for consumer health, whereas leave-on personal care products were the most damaging to population-level human health. Conversely, outdoor spray insecticides, floor cleaning liquid, laundry detergent, bath oil, and surface cleaner were the most damaging products to ecosystems. Human health and ecosystem damage differ by chemical-product combination, underscoring the need for individualized risk assessments depending on target receptors of concern. 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.

Keyword:ecological exposure, environmental health, consumer and personal care products

1040107

Inter-individual Variability and Non-Linear Dose-Response Relationship in Assessing Human Health Impact from Chemicals in LCA: Addressing Uncertainties in Exposure and Toxicological Susceptibility

D. Li, L. Li; University of Nevada, Reno

Abstract: Current life cycle impact assessment (LCIA) practices use a characterization factor to linearly scale chemical emission to human health impact assuming a homogeneous exposure and toxicological susceptibility for the entire population. However, both exposure and toxicological susceptibility may vary within the population, making the same emission elicit disproportionate impacts. Here we explore how inter-individual variabilities in human exposure and toxicological susceptibility interact to affect the estimated overall health impacts on the population level. For exemplification, we use the PROTEX model to simulate the exposure of the general American population to dieldrin and heptachlor, two organochlorine pesticides that tend to accumulate in food items. Using a Monte-Carlo analysis, we characterize inter-individual variabilities in exposure by considering variations in anthropometrics and dietary patterns between ages, sexes, and racial groups. We assess the overall health impact on the population level in five scenarios with different combinations of assumptions in exposure (homogeneous/heterogeneous) and the dose-response relationship (linear/non-linear, homogeneous/heterogeneous susceptibility). Our results indicate human exposure can vary by a factor of six among the different demographic groups. Combined with a non-linear dose-response relationship with heterogeneous susceptibility, the estimated overall health impact is substantially higher than the results using homogeneous susceptibility. However, the current LCIA practice of using a linear dose-response relationship produces even higher results that may overestimate the health impacts.

Keyword:exposure models, susceptible/vulnerable, lifecycle analysis

1033622

Ambient ozone, weight status, and pediatric asthma hospitalizations in the Bronx, New York

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Abstract: This study assessed the effect of high O3 episodes on daily pediatric asthma hospitalization and length of stay. It also examined whether this effect differed by weight status. Pediatric (2-18 years) asthma hospitalizations at a large academic children's hospital in the Bronx during the ozone season (April to September) from 2017 to 2019 were analyzed. The daily 8-hr maximum ozone concentrations were obtained from US EPA AirData. The Spearman correlations between ambient O3, daily admissions and length of stay (LOS) were computed for day of and lag days 1-7. Linear regression was used to assess the effect of high ozone episodes (> 50 ppbv) on LOS controlling weight status, age, gender, asthma severity and viral infections. A total of 816 admissions were analyzed. Most were younger than 5 (53%), of Hispanic origin (49%), and with intermittent symptoms (53%). Forty percent were overweight or obese, 15% had known smoking exposure, and 10% had a positive result in the viral panel. Thirty three percent were admitted on a day where O3 was greater than 50 ppb. There were weak or no correlations between levels and numbers of admissions or patient LOS, regardless of which lag day was analyzed (all r <.115). There was also no correlation between O3 and percent of admits who were overweight or obese. Regression with calculation of standardized beta coefficient revealed that the only variables associated with LOS with p <.0001were positive viral results (-.396), older age of 13-18 (.116), and classification of persistent asthma (.115). Female gender (.039, p = .219), being obese or overweight (.035, p = .284), and O3 > 50 ppb on day of admission (.010, p = .991) were not associated with LOS. Ambient ozone may adversely affect childhood asthma, particularly in minority communities lacking access to health care and asthma management. The poor correlations between O3 and hospitalizations/LOS in this study may be due to limited time spent outdoors because of high temperature associated with high O3 levels. This study also only assessed hospitalizations, and it is possible that O3 may be more strongly correlated with other, milder measures of asthma exacerbations such as ER visits or symptomatic episodes at home. Delineating the overall O3 effect requires a better understanding of factors affecting O3 exposures as well as asthma exacerbations.

Keyword:asthma, air pollution, children

1044479

Temporal Trends of Phenol and Paraben Exposure in California Pregnant Women during 2007-2016: Implications from Comparison with Other Populations

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Abstract: Background/Objective: Environmental phenols and parabens with known adverse health effects are being regulated or replaced with alternatives. Little is known about temporal trends of pregnant women's exposure to phenols and parabens in the United States (U.S.) Methods: We quantified five phenols and four parabens in 779 urine samples collected during 2007-2016 from 232 California pregnant women during their second and third trimesters of pregnancy participating in the MARBLES (Markers of Autism Risk in Babies – Learning Early Signs) study. We used multiple regression to estimate least square geometric means of urinary concentrations and computed average annual percent changes. We also compared our urinary concentrations with those of other study populations to examine geographic variations in pregnant women's exposure. Results: Urinary concentrations of bisphenol A, methyl paraben, ethyl paraben, and propyl paraben decreased in California pregnant women over the study period [percent change per year (95% confidence interval): -3.7% (-6.3%, -1.1%); -14.3% (-19.2%, -9.2%); -5.3% (-10.8%, 0.5%); -12.6% (-17.6%, -7.2%), respectively] and were consistently lower than those in pregnant women in other U.S. regions during the same study period. Hispanic pregnant women tended to have higher urinary concentrations of three parabens than other subgroups of race/ethnicity. Conclusions: Decreased urinary concentrations of some phenols and parabens in California pregnant women over the study period appeared to be responses to national regulations or advocacy campaigns in California. Further biomonitoring studies are recommended to include substitutes of phenols and parabens under regulation.

Keyword:biomonitoring, longitudinal metrics, consumer and personal care products, temporal trend

1051756

Exposure profile of PFAS among children and adolescents of Korea and potential pathways of exposure – Korea FDA Specimen Archive of 2018

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Abstract: Per and polyfluoroalkyl substances (PFASs) are a group of multiple compounds that are used in various industrial applications such as waterproofing products and firefighting products due to their properties. For this reason, many PFASs have been frequently detected in humans worldwide. In Korea, however, the biomonitoring of PFASs has been mostly focused on adult populations, and no studies have been reported for a nationally representative population. In the present study, we employed the archive of representative Korean blood and urine samples for biomonitoring of exposure to hazardous materials established by Korea Food & Drug Administration (20162MFDS118), and evaluated the

current levels of exposure and potential pathways among the children and adolescents. The serum samples of 561 subjects including 6-12 aged children (n=258), and 13-18 aged adolescents (n=303) were Based on age and sex structure of general Korean population census, and a total of 30 PFASs were analyzed using an LC-MS/MS technique. Questionnaire results were analyzed and compared with the PFAS exposure to identified major determinants of exposure among the children and adolescents. The average (standard deviation) age of the participating children and adolescents was 9.74±1.63, and 15.13±1.46 years old, respectively. Ten PFASs, including PFHxA, PFHpA, PFOA, PFOS, and PFNA, were detected in over 85% samples. In both age groups, PFOA was detected at the highest levels (median), i.e., in children at 3.67 ng/mL, and in adolescents at 2.92 ng/mL, and PFHpA was detected at the lowest level (median), i.e., in children at 0.087 ng/mL, and in adolescents at 0.067 ng/mL. Especially except PFHpA, and PFDA, 9 of PFASs concentrations were higher in children than in adolescents . The levels of detection were different between the age groups in all 13 frequently detected PFASs, except for PFTrDA. In both age groups, PFAS levels were high with greater fish (roasted, boiled) consumption, and lessor milk consumption. The current observations can be used to identify priority PFASs among general population of different age groups and to develop refined exposure assessment.

Keyword:PFAS, biomonitoring, exposure factors, human-population

1051773

Human exposure pathways to poly- and perfluoroalkyl substances (PFAS) from indoor media: A systematic review

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Abstract: Human exposure to per- and polyfluoroalkyl substances (PFAS) has been primarily attributed to contaminated food and drinking water. However, PFAS exposure has also been linked to use of consumer products, yet few studies report relationships between these exposure media and human biomonitoring measurements. A systematic review (SR) is a transparent and rigorous method to evaluate a body of scientific evidence to answer a specific research or policy question. Although widely used in clinical medicine and epidemiology, the development of SR methods that are applicable to exposure science studies is ongoing. This study adapted existing SR methodologies to identify important PFAS exposure pathways from indoor environment media including consumer products, household articles, cleaning products, personal care products, and indoor air and dust. Studies included in the SR report exposure measures from household media paired with occupant PFAS concentrations in blood serum, focusing specifically on eight frequently measured chemical species of PFAS. Machine learning approaches were used during the literature scoping and title/abstract screening to prioritize exposure pathways of interest by automated tagging and to select studies for inclusion using an iterative predictive screening model. The extraction of exposure measurement data and study characteristics from each included study was performed in DistillerSR software. Exposure intake calculations were used to estimate a percentage of occupant serum concentrations that could be attributed to indoor exposure pathways. The exposure assessment methods used in included studies were evaluated using an approach modified from the EPA’s Systematic Review Protocol for IRIS Assessments and the

Navigation Guide. Along with providing evidence for an estimated range of indoor exposure media's contribution to serum PFAS concentrations, this systematic review highlights the limited availability of concordant measurement data from indoor exposure media and participant serum. It also presents innovative SR methodologies for exposure science studies, including the development of exposure pathway-specific search strings for use in artificial intelligence software.

Keyword:exposure models, built/indoor environment, PFAS

1050772
A Cohort Study of Appalachian Firefighters' Exposure to and Perception of Risk
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Abstract:A Cohort Study of Appalachian Firefighters' Exposure to and Perception of Risk Abstract Both police and career (paid) firefighters are in the top fifteen occupations for risk of fatal occupational injury, and the traumatic fatality rates are approximately three to four times higher than the average for all occupations. The injuries most frequently experienced by firefighters are traumatic injuries, cuts and bruises, burns, asphyxiation, other respiratory injuries, and heat stress. Physical stress and overexertion, falls, being struck or contacting objects, and exposure to fire products are the primary causes of injury at the fire scene. Physical stress, being lost or trapped in a fire situation, and vehicle crashes are the primary causes of death. Respiratory chemical and physical exposures are the main causes of cancer and respiratory illness. Physical stress is responsible for nearly half of all on-duty deaths. Approximately 88,000 firefighters are injured each year; about 2,000 of their injuries are potentially life-threatening. Most physical injuries to firefighters occur on scene, 'on the fireground' during the fire attack, search, and rescue, however, it is believed that most respiratory chemical exposures occur during overhaul and turnout gear storage. Additional injuries / exposures occur from foam-based fire extinguishing materials and activities such as the use of fire apparatus or falls during overhaul operations. The cohort for this study was the 8,845+ volunteer firefighters in the 54 Appalachian counties in Kentucky comprising 345 volunteer fire companies with only 10 departments listed as paid professional services. Numerous articles have identified the known and recognizable health and safety issues that firefighters encounter when responding to a fire, as reported to worker compensation providers (Rand, 2011). However, to date, there has not been a robust survey focused solely on volunteer firefighters and what they perceive and recognize as risks and hazards to their own safety and health. Additionally, there is scant reporting of "near miss" incidents where the firefighter narrowly escapes injury during a fire. Additionally, respiratory hazard exposures remain problematic as complete training in respiratory protection is limited to SCBA's.

Keyword:occupational exposure, respiratory health, air pollutants

1050923
Urinary Amino-Polycyclic Aromatic Hydrocarbons in Urban Residents: Finding a Biomarker for Residential Exposure to Diesel Traffic

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Abstract: Despite substantial evidence of marked exposure to and ill-health effects from diesel exhaust (DE) emissions among occupational population (e.g., miners, truck drivers and taxi drivers), it is less understood to what extent non-occupational population are exposed to DE, largely due to the lack of biomarkers that would indicate specific exposure to DE. We evaluated whether urinary amino-polycyclic aromatic hydrocarbons (APAHs), such as major metabolites of DE-specific nitrated PAHs, can be used as DE exposure biomarkers in residential settings. We measured five urinary APAHs in 177 urine samples from 98 UK residents, 89 (91%) of whom were London residents, and estimated participants' residential proximity to various traffic indicators (e.g., road type, road length, traffic flow and traffic volume). Participants living within 100 m of major road exhibited increased levels of all five APAHs, among which 2-amino-fluorene (2-AFLU) reached statistical significance ($p<0.05$). We estimated that a 10 m increase in the length of nearby major roads (< 100 m) was associated with 4.4% (95% CI: 1.1 to 7.6%) increase in 2-AFLU levels. Levels of 2-AFLU were significantly associated with the traffic flow of nearby buses, and heavy-duty vehicles, but not motorbikes, taxis, or coaches. These results support the use of urinary 2-AFLU as a biomarker of DE exposure in urban residents.

Keyword:air pollution, biomarkers, biomonitoring

1053608

Potential Demographic Differences in Chemical Exposure Derived from Purchasing and Consumer Ingredient Data Streams

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Abstract: Consumer products that are used in and around the home are a dominant source for anthropogenic chemical exposure. Prediction of the population distribution of chemical exposures encountered due to the residential use of consumer products (such as personal care products, cleaning products, pesticides, and pet products) require information about the corresponding distribution of consumer product use as well as information about the ingredients in those products. Here we aim to explore potential demographic disparities in exposure emerging from consumer product use. For a population of sixty thousand households, we merged product purchasing data with a database of chemical ingredient information collected from Safety Data Sheets and ingredient lists. We explored purchasing patterns (habits and practices) and resulting chemical introduction into homes in terms of demographic groups based on race/ethnicity, income, and education. We specifically examined demographic differences in purchases and associated chemical content of key product types, including household cleaners and disinfectants, residential pesticides, hair-care products, and cosmetics. We further considered the impact of brand type choice (e.g., store, mass market, or specialty brand) on the introduction of chemicals into households. Lastly, using data-mining methods, we investigated demographically stratified co-occurrence patterns in product purchases and in resulting potential chemical exposures. We demonstrated the impact of these demographic factors and purchasing choices via application to a case

study group of potential endocrine active chemicals (EACs) as identified by consensus in vitro-based models of estrogen and androgen activity. In general, across all products and by product type, our results indicated that households with children, households headed by women of color, and lower income households exhibited divergence from the general population in the chemicals and chemical combinations they encounter most frequently. In addition, brand type choice in select product categories (including cleaning products and cosmetics) varied over demographics and contributed to patterns of EACs introduced to homes. These results indicate that consumer habits and practices potentially contribute to exposure disparities observed in biomonitoring studies. This abstract does not reflect EPA policy.

Keyword:consumer and personal care products, cumulative exposure, susceptible/vulnerable

1054048

Characteristic of 3D-pen emitted ultrafine particles and the effect of partition on ultrafine particle exposure during 3D-pen operation

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Abstract: Abstract Three-dimensional (3D) printing pen is a portable 3D-printer, increasingly used among children. Processing thermoplastic filaments with a 3D-pen could emit ultrafine particles (UFPs). Because 3D-pen education sessions are held within "ㄷ"-shaped partitions for Coronavirus disease-19 (COVID-19) prevention, unintended UFP exposure could occur. It was necessary to characterize 3D-pen emitted UFPs to help prevent adverse health effects from UFP exposure. Characteristics of UFPs emitted from two types of 3D-pen were compared and the influence of partition was evaluated. Particle characterization experiment was conducted in a chamber (2.5 m3) to measure emission rates and size distributions of 3D-pen emitted particles. Evaluation of partition's influence on exposure to UFPs was implemented on a desk with "ㄷ" - partition installed. A scanning mobility particle sizer (SMPS NanoScan Model 3910, TSI Inc., Shoreview, MN, USA) and an optical particle spectrometer (OPS Model 3330, TSI Inc., Shoreview, MN, USA) were used for particle number concentration and size distribution measurements. 3D-pen A emitted more particles than 3D-pen B and emission rates were the highest for ABS. For all filaments, particles in the Aitken mode (30-100 nm) accounted for the highest proportion. For both 3D-pens, particle number concentrations (PNCs) were higher with the partition installed and was maintained above background level until the operation ended. However, mass concentration of 3D-pen A was higher without the partition during PLA and PCL processing. Guidelines for safe use of 3D-pens are required for reducing UFP exposure of children during 3D-pen operation.

Keyword:particles, nanoparticles, other (specify below), 3D-pen; ultrafine particles; thermoplastic filament; partition; exposure

1054130

Trends in urinary metabolites of polycyclic aromatic hydrocarbons (PAHs) in the non-smoking U.S. population, NHANES 2001–2014

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Abstract: Title: Trends in urinary metabolites of polycyclic aromatic hydrocarbons (PAHs) in the non-smoking U.S. population, NHANES 2001–2014. Background: Recent studies indicate airborne PAH levels have decreased in the U.S., but it is unclear if this has resulted in PAH exposure changes in the U.S. population. Objective: Examine temporal trends in urinary metabolites of Naphthalene, Fluorene, Phenanthrene, and Pyrene in U.S. non-smokers, 6+ years old. Methods: We used biomonitoring data from the National Health and Nutrition Examination Survey (NHANES) program, 2001-2014, (N=11,053) using survey weighted linear regression. Models were adjusted for age, sex, race/ethnicity, creatinine, BMI, income, diet, and seasonality. Stratified models evaluated the effect of age, sex, and race/ethnicity on trends. Results: Between 2001-2014, Naphthalene exposure increased 36% ($p<0.01$); Pyrene exposure increased 106% ($p <0.01$); Fluorene and Phenanthrene exposure decreased 55% ($p <0.01$), and 37% ($p<0.01$), respectively. Naphthalene was the most abundant urinary PAH, 20-fold higher than Fluorene and Phenanthrene, and over 50-fold higher than Pyrene compared to reference groups, effect modification was observed by age (Naphthalene, Pyrene), sex (Fluorene, Pyrene), and race/ethnicity (Naphthalene, Fluorene, Phenanthrene, Pyrene). Non-Hispanic Black participants had highest PAH exposures overall and the greatest increases over time. Mexican American participants had higher Naphthalene and Pyrene exposure compared to Non-Hispanic Whites. Significance: This study shows exposure to Naphthalene and Pyrene increased, while exposure to Fluorene and Phenanthrene decreased among the non-smoking U.S. general population between 2001-2014, suggesting environmental sources of PAHs have changed over the time period. Effect modification by race/ethnicity indicates disparities in environmental exposures to PAHs.

Keyword:biomonitoring, air pollution, environmental health

1054169

Genetic polymorphisms of cytochrome P450 enzymes and DEHP metabolism

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Abstract: Among phthalates the most extensively studied is diethylhexyl phthalate (DEHP). Various epidemiological, in vitro, and animal studies reported on its: i) endocrine disruptive effects, ii) rapid metabolism via cytochrome P450 (CYPs) enzymes, specifically CYP2 C9, C19, and D6, iii) assumed higher toxicity of metabolites than the parent compound and iv) large inter-individual variability in patterns of its metabolites in human urine. For the latter, genetic polymorphisms of metabolizing enzymes were proposed as an important contributing factor, but have not yet been investigated. Therefore, the aim of the present study was to investigate the possible role of polymorphisms (SNP) in CYP2C9, CYP2C19 and CYP2D6 genes on DEHP metabolism in a Slovenian adult population of 274 men and 289 lactating women, recruited within the first national HBM in 2008 – 2014. CYP2 SNPs namely 2C9*2, 2C9*3 , 2C19*2 , 2C19*17, and 2D6*4 were tested for associations with urinary levels and ratios of primary (MEHP) and secondary (OH-MEHP, oxo-MEHP, and cx-MEPP) DEHP metabolites by multiple linear regression analyses. Carriers of C9*2 allele had lower urine levels of OH-MEHP (coef.:-0.26), oxo-MEHP (coef.:-0.28) and cx-MEPP (coef.:-0.35) in men, and a lower cx-MEPP/MEHP ratio in men and women (coef.:-0.24 and -0.23,

respectively), compared to wild type carriers. Similarly, the presence of C9*3 resulted in lower oxo-MEHP/MEHP (coef:-0.19), cx-MEHP/MEHP (coef:-0.38) and oxo-MEHP/OH-MEHP (coef:-0.13) ratios among men, lower cx-MEPP urine levels (coef:-0.16) and cx-MEPP/MEHP ratio (coef:-0.46) among women. Moreover, carriers of combined C9*2 and C9*3 alleles (n=9) expressed an even lower capacity in production of secondary metabolites, with cx-MEPP being lower for ~50%, compared to wild type individuals for both SNPs. Regardless of the gender the impact of both SNPs was the most noticeable on the production of cx-MEPP. Contrary, the C19*17 SNP resulted in significantly increased excretion of all secondary metabolites (coef: 0.30 – 0.36) in men and women, however no influence on metabolite's ratios were observed. Using human biomonitoring data, the present study confirmed the effect of C9*2 and C9*3 SNPs on both, substrate specificity and catalytic activity of CYP2C9 enzyme towards MEHP metabolism; previously observed only in vitro. Moreover, we show that C9*2, C9*3, and C19*17 could represent important biomarkers of susceptibility in DEHP exposure that have been so far unrecognised.

Keyword:phthalates, biomonitoring, other (specify below), DEHP, single nucleotide polymorphisms, CYP2C9, CYP2C19, susceptibility

1054246

Biomonitoring of DEET and two metabolites in Canadian children following typical protective insect repellent use

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Abstract:N,N-diethyl-meta-toluamide (DEET) is an ingredient found in insect repellents and is approved by Canadian government agencies for protection against biting insects. Most research on DEET exposure and toxicokinetics has focused on adult populations, with little data from vulnerable populations, including children. An observational exposure human biomonitoring study was conducted at three overnight summer camps in Ontario, Canada, through July and August 2019. Participating children aged 7 to 13 (mean 11) years attending summer camps provided multiple spot urine samples for a 24-hour period and completed a journal to document insect repellent use and factors that could influence absorption. Urine samples were analysed for DEET and two metabolites, N,N-diethyl-meta-hydroxymethylbenzamide (DHMB) and 3-diethylcarbamoyl benzoic acid (DCBA). The majority of children (62%) used insect repellents with DEET concentrations ≤10% DEET, as directed in Canada for children in this age group. Repellent containers were weighed before and after the study to determine the amount of product used. In total, 389 urine samples were collected from 124 children. Children excreted only a small proportion of the estimated amount of applied DEET as DEET and metabolites, based on the change of the insect repellent container mass over the study period. Geometric mean concentrations of DEET and metabolites in urine increased with higher estimated exposure. Lab analyses also show that children who used more insect repellent had higher concentrations of DEET and metabolites in urine. We observed that among participants using insect repellent, urinary levels of DEET were elevated between 2 and 8 hours post insect repellent application, and decreased thereafter. Similarly, the metabolites DHMB and DCBA were elevated between 8 and 14 hours post-application, and declined thereafter. DEET, DHMB, and DCBA concentrations

remained qualitatively higher even at 18 to 22 hours post-application, but did not decline to the levels observed among those who did not use insect repellent during the study day. Results suggest that children's typical use of DEET-based insect repellents results in only a small percentage of absorption and excretion of applied DEET. The change in urinary DEET and metabolite concentrations over time is supported by previous studies in adults that showed an increase after DEET application, and eventual decrease in excretion of DEET and metabolites over 24 to 48 hours.

Keyword:biomonitoring, children, other (specify below), DEET

IMPACTS OF PUBLIC HEALTH POLICY

1054020

Using the theory of planned behavior as a framework to characterize electronic cigarette use among U.S. adult cigarette smokers

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Abstract: Background Prevalence of current e-cigarette use among cigarette smokers ("dual use") was around 27.7% in 2018, even though no solid evidence shows dual use is associated with reduced harm. Identifying the predictors that determine dual use will help policy makers design interventions for possible prevention or harm reduction. Objective To assess factors that determine dual use among U.S. adult smokers. Methods We used the Theory of Planned Behavior (TPB) as a framework to assess factors (including intention, attitude/perceptions, subjective norms and perceived behavioral controls on tobacco products) that determine dual use among U.S. adults. Adult cigarette smokers were included for the present analysis using data from Waves 2 & 3 of the Population Assessment of Tobacco and Health (PATH) Study. Bivariate logistic regression and Generalized Estimating Equation (GEE) models were used to examine TPB factors associated with current dual use. Classification and regression tree (CART) analyses were used to identify the combination of TPB factors that could achieve the most exploratory power to characterize current dual use among smokers and create a hierarchical decision tree. Results There were 645 dual users (11.6%) out of 5,568 cigarette smokers in Wave 2. Smokers who have ever considered switching to e-cigarette were about 7-fold more likely to be dual users than those who never considered so (OR [95% CI]: 6.9 [4.1-11.7]). Compared to smokers that perceived "e-cigarette is less harmful" than regular smoking, those who perceived e-cigarette "about the same harmful" (OR [95% CI]: 0.23 [0.20-0.27]) or "more harmful" (OR [95% CI]: 0.09 [0.06-0.13]) were less likely to be dual users. Results from CART showed similar results. The most influential factor for dual use was harm perception of e-cigarettes compared to cigarettes, followed by intention to switch to e-cigarettes, and behavior controls. Conclusions Intention to switch to e-cigarette, less harmful perception of e-cigarette, subjective norms, and perceived behavioral control contributed significantly to dual use among smokers. Thus, the potential risks of e-cigarettes must be communicated to smokers. Also, social norms could be guided and behavioral control should be strengthened for early prevention of dual use among smokers.

Keyword:behavior, policy, public health

1049461

Working from home and office during COVID-19 pandemic: how do exposure levels vary?

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Abstract: As known, the COVID-19 pandemic is raging worldwide: to limit the number of deaths and hospitalizations due to the novel coronavirus, most governments decided to suspend many economic activities and restrict people's freedom of mobility. In this context, when possible, working from home has become increasingly important and it might become a traditional way of working in many economic sectors. Different studies have appeared in the literature regarding the possible implications of working from home (e.g.: work-related stress) but, to the best of our knowledge, no studies have yet been performed considering the differences between working from home (WFH) and working from office (WFO) conditions, in terms of exposure assessment to different air pollutants. The principal aim of this study is therefore to quantitatively evaluate the differences, in terms of daily exposure to different atmospheric pollutants, between different working conditions. Using literature data regarding (i) the use of time for different categories of subjects (males/females and employed/students) and (ii) concentration levels of exposure to different PM fractions (PM1, PM2.5 and PM10) in different environments (office, home and commuting environments) in different seasons (summer/winter), through a Monte Carlo simulation, the daily exposure was calculated for the different categories of subjects investigated in different working conditions (WFO and WFH). The main results of this work show how, in all WFO situations (in terms of season, gender and type of worker - employee or student), the median values of the concentrations of the various PM fractions considered are significantly higher than to those associated with WFH situation (verified via Mann-Whitney test). The results of this preliminary study show how working from home exposes, probably due to the missed commuting period, to lower PM concentrations than those found in a typical working day at the office. Ad hoc monitoring will have to be carried out in the future to investigate this issue, also considering and detailing the possible sources of domestic pollution.

Keyword:air quality, pandemic, exposure factors

1052355

Walking Time to Urban Public Green Spaces – a Socioeconomic Inequality Analysis in the German Environmental Survey for Children and Adolescents (GerES 2014-2017)

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Abstract: Background Public green spaces (PGS) are relevant in exposure science and environmental health: PGS help reducing heat exposure and may also improve air quality, especially in urban areas. PGS support physical activity, relaxation, and social interaction. The latter gained importance concerning COVID-19, as urban PGS turned out to benefit social contact and outdoor activities in case of pandemic-related restrictions. To investigate

socioeconomic disparities in PGS accessibility, walking time of children and adolescents to PGS from home was investigated in the population-representative German Environmental Survey for Children and Adolescents 2014-2017 (GerES V), the environmental module of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS Wave 2). Methods KiGGS Wave 2 collected i. a. sociodemographic data on the participants (3-17 years). Socioeconomic position (SEP) was defined as index of parental education, occupation and household income. For participants also included in GerES V, walking time to PGS from home was recorded in parental interviews. In this study only participants living in urban areas of 20,000+ inhabitants were considered. Results 72.8% of the participants were reported to walk up to 10 min to a PGS. For almost 5% the walk was over 30 min. Bivariate comparison revealed significant differences by SEP. Generally, walking time decreased with SEP. In logistic regression controlling for age, sex, migration background, and region of residence, participants with a low SEP were more likely to walk more than 10 min than high SEP participants (OR: 1.98, 95%-CI: 1.31-2.99). Conclusions and Outlook The young generation with a low SEP is observed to have poorer access to PGS in urban communities which might add to already existing exposure and health disparities. GerES V documents the need for considering socioeconomic aspects of health in urban planning. Including spatial information on PGS and other exposure-relevant aspects in GerES V data analysis could help further elucidating environmental justice issues in Germany. Acknowledgements We wish to thank all study participants. Thank is also due to Kantar Health GmbH for GerES V field work. Funding by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Federal Ministry of Education and Research, and the Federal Ministry of Health is gratefully acknowledged. Results published at: https://doi.org/10.3390/ijerph18052326.

Keyword:environmental health, environmental justice, epidemiology

1054311

Evaluating the Impact of California's Prop 65 on Population Chemical Exposures Using NHANES

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Abstract: Environmental right-to-know laws such as California's Proposition 65 (Prop 65) compel businesses to warn about potential exposure to harmful chemicals in their products, workplaces, or the environment. In the 35 years since its enactment, no systematic analysis has addressed what, if any, effect Prop 65 has had on population-level exposures to the carcinogens and reproductive/developmental toxicants listed under the law. While it is difficult to separate the effect of Prop 65 from other market forces, multiple instances of product reformulation following Prop 65 enforcement actions show the potential of the law to change exposure patterns. Additionally, the act of listing a chemical under Prop 65 has on its own prompted a range of regulatory and non-regulatory actions that drive product reformulation that may then be attributed indirectly to Prop 65. In addition, while Prop 65 only requires warnings on products sold in California, any resulting product reformulations are expected to drive exposure patterns nationwide. To quantify the impact of Prop 65 on population-level exposures to chemicals listed under the law, we analyzed biomonitoring data

collected through the National Health and Nutrition Examination Survey (NHANES) between 1999 and 2016. Our analyses--survey-weighted and adjusted for demographics--included 37 chemicals: 11 listed on Prop 65 prior to the start of biomonitoring, 11 listed during the biomonitoring time period, 3 listed later, and 12 not Prop 65-listed but from a similar chemical class as a Prop 65-listed chemical. Exposures decreased over time for lead, cadmium, mercury, and 2,5-dichlorophenol, which were all listed prior to the start of the biomonitoring. Exposures to lead, 2,5-dichlorophenol and several of the PAHs were significantly lower in California than the rest of the U.S. For 11 chemicals added to California's Prop 65 list from 1999 to 2016, we estimated a difference-in-differences model, which allowed us to compare the impact of changes associated with the Prop 65 listing on chemical exposures in California versus the rest of the U.S. Following listing, exposures decreased in both California and the rest of the U.S. for 7 of the 11 chemicals. Meanwhile, exposures to several closely-related chemicals that were not Prop 65-listed increased, suggesting manufacturers substituted non-listed chemicals for listed chemicals. Listing on Prop 65 often coincides with reduced exposures nationwide.

Keyword:biomonitoring, environmental regulation, regression

MULTIPLE STRESSOR INTERACTIONS

1054397

Retrospective analysis of simultaneous noise and air pollution measurements near a highway: ranking the relation between multiple air pollutants, meteorological condition, traffic and spectral noise using non-linear techniques (gam)

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Abstract: In May 2011 ambient levels of particulate matter and nitrogen oxides were measured in the Netherlands along with noise, performed for the Environmental Research Bureau of the province Limburg (ERBLimb). In the resulting report, only NO and UFP were found to be marginally correlated with noise. In contrast, the work performed at Ghent University shows a strong correlation between low frequency – engine related - noise and Black Carbon. To achieve the predictive model for Black Carbon, the spectral content of the noise and the non-linear aspects of the meteorological conditions are included. At UGent the results were achieved in the context of bicyclist exposure in an urban context. The technique shows potential at fixed locations. Applying this modelling approach on the multi-pollutant data collection of ERBLimb can give additional insights in the correlation, or lack of correlation between traffic, noise and a more extended set of air pollutants. The spectral content of ERBLimb is less detailed compared to the model of UGent, but the information is good enough to be aligned with the spectral content parameters in the UGent approach: engine noise (OLF) and cruising noise (HFmLF). OLF is related to engine throttle which is related to excess air pollution emissions due to below optimal operation of the combustion engines, while cruising noise is related to the speed of traffic. Engine noise is also correlating with the amount of heavy vehicles. During rush hour, the relative contribution of heavy traffic drops which results in significant interactions. Free flow traffic also emits less air pollution compared to a dynamic traffic situation. These combined features are indirectly available in the spectral noise parameters. The spectral noise itself is strongly correlated with the traffic

counts. For NO and NOx, the spectral noise results in a stronger predictive model compared to the traffic data, improving the prior results. For the large PM fractions, the approach fails for both traffic counts and noise parameters. For UFP, the correlation is hugely affected by the relative humidity and wind speed. The Grimm based UFP fractions correlate with the engine noise after adjusting for humidity, wind speed and wind direction. More sensitive modelling relates the UFP exposure to the traffic dynamics on the highway but the dominant factor is meteorology. The poor relation between UFP and traffic volumes and traffic flow is a drawback for health impact assessments.

Keyword:acoustics/noise, air pollutants, fine particlate matter

1054427

Individual, independent, and combined effects of toxic metals and manganese on hypertensive disorders of pregnancy

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Abstract: Background Exposure to lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) may be associated with a higher risk of developing gestational hypertension or preeclampsia, while manganese (Mn) is an essential mineral that may be protective. We estimated the individual, independent, and mixture effects of maternal blood Pb, Cd, As, Hg, and Mn concentrations on the risk of developing these conditions in the Maternal-Infant Research on Environmental Chemicals pregnancy cohort. Methods Metal concentrations were analyzed in 1st and 3rd trimester maternal blood (n=1560). We measured blood pressure to diagnose gestational hypertension while proteinuria and other complications defined preeclampsia. Women with pre-existing hypertension were excluded. We estimated individual and independent (adjusted for co-exposure) multivariable associations for each doubling of blood metal concentrations. We used quantile g-computation to estimate the mixture effect of a simultaneous, one quantile increase in all trimester-specific exposures. We explored potential fetal sex-specific effects with 819 and 741 women carrying male and female fetuses, respectively. Results Ninety percent of women had normal blood pressure, 7% developed gestational hypertension, and 3% developed preeclampsia. In individual multivariable models, each doubling of 1st trimester Mn concentrations was associated with a lower risk of developing gestational hypertension among women carrying male fetuses only (RR=0.55; 95% CI: 0.33, 0.92; fetal sex interaction p=0.009). None of the other metals, at either time point, were individually associated with developing either condition. After adjusting for co-exposure to other metals, the protective effect of Mn was retained and 3rd trimester blood Pb concentrations were independently associated with a higher risk of developing preeclampsia (RR=1.54, 95% CI: 0.97, 2.49). In quantile g-computation models, simultaneously increasing all exposures by one quantile was not associated with the risk of developing either condition. Conclusion Our results confirm that even low (< 5 μg/dL) blood lead concentrations are a risk factor for preeclampsia and suggest that the protective role of Mn is sex-specific. This study highlights the importance of considering individual, independent, and combined analyses to

examine the effects of multiple chemicals, and reinforces the value of incorporating multiple measures of exposure throughout pregnancy and exploring sex-specific effects.

Keyword:biomonitoring, metals, prenatal

1054452

Toxicokinetic interactions of industrial chemical mixtures as internal exposure modifiers

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Abstract: Single chemical exposure is an exception rather than the rule in the general and occupational environments. For this study thee relevant mixtures of chemicals were investigated. The first one is the bisphenols' mixtures consisting of bisphenol A, S and F, the second one is the phthalates' mixture consisting of DEHP, BBzP, DnBP and DiNP and the third one of BTEX (benzene, ethylbenzene, toluene and xylene). In order to evaluate the inhibitory effect on the metabolism as a result of co-exposure, a broad range of mean daily intake levels (bodyweight normalised) have been tested for bisphenols and phthalates, starting from 0.01 up to 100,000 μg/kg bw/day, while for the BTEX, the TLV's for the four chemicals considered herein have been used. From the results of the co-exposure interaction, it was clearly shown that under environmentally relevant exposure levels and even at the level of EFSA's temporary tolerable daily intake (tTDI) of 4 μg/kg bw/d for bisphenol A and 50 μg/kg_bw/d for DEHP, the effect of interaction on the internal dose (expressed as increase of the Area Under Curve, AUC) is negligible (below 1%). However, as expected, the interaction effect is higher when the daily intake level increases. The interaction is significant for intake levels above 10,000 μg/kg bw/d, which might be relevant only for occupational settings. Similarly, for BTEX, the changes in internal dose upon inhalation exposure are dose dependent, and they become more evident as we move closer to the TLV. From all the case studies, it is evident that co-exposure to chemicals that are subjected to interaction at the level of metabolism, is crucial at high exposure levels, that are mostly met in occupational settings. Thus, although in environmentally relevant exposure levels, interactions at the level of metabolism regarding cumulative exposure might not be a major concern, they have to be taken into account when estimating or apply the exposure-response relationships. Hense, these results indicate, that a broader framework of interactions that affect bioavailability upon cumulative exposure might need to be investigated, as well as integration of toxicokinetic and toxicodynamic models (and more specifically biology based dose response models); in our view this has to be the next step in cumulative exposure risk assessment, and qAOPs (quantitative adverse outcome pathways) seem to be the ideal substrate towards this direction.

Keyword:PBPK Modeling, metabolism, cumulative exposure

1054464

ROS-MEDIATED LUNG STRESS FOLLOWING EXPOSURE TO ZN AND FE NANOPARTICLES. A MECHANISM FOR METAL-FUME FEVER ?

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Abstract: Metal Fume Fever (MFF) is a transient disease associated with welding and metal-related process involving high temperatures and most particularly galvanized steel welding. The onset of symptoms occurs typically 4-10 h following the cessation of exposure to metal-containing fumes. Although its precise physiopathology is still unknown, an oxidative stress mechanism has been hypothesized. Welding produces strong UV-light, and there evidence that the ability of metal-containing particles to produce ROS is influenced by environmental conditions such as light. Fenton reaction are moderately effective in producing ROS but, in the presence of light, energetically improved reactions takes place in the form of two main chemical mechanisms respectively known as photo-Fenton and semi-conductor-like photocatalysis. This study investigates the capability of ZnO and Fe3O4 particles, both fund abundantly in galvanized steel welding, to induce oxidative stress via photo-driven mechanisms. Laboratory measurement were conducted in order to evidence the presence of photocatalytic and photo-Fenton reactions. Our results showed that while ZnO exhibited photo-catalytic properties, the ROS (photo)-activity of airborne Fe3O4 particles was very low, suggesting that a direct mechanism is unlikely. Then we explored if such reactions might be promoted by a preliminary reaction between the Fe-nanoparticles and biological ligands (citrate, oxalate, and artificial mucus) before exposure to H2O2, mimicking the ROS production of photocatalytic ZnO. A Fenton reaction was clearly observed for Fe(II), Fe(III) and Fe3O4 NP in the presence of biological ligands (mucus, oxalate, citrate),at physiological pH, while no Fenton reaction was observed in the absence of ligands. The physiological importance of the dose of ROS emitted by the particles was confirmed in vitro on a 3D lung system. Our findings suggests that a photo-induced mechanism is a credible hypothesis for the appearance of MFF, a disease known since the middle age and still poorly explained. More broadly, it emphasized the role of environmentally-induced ROS mechanism in nanoparticles, as opposed to an innate oxidative capacity.

Keyword:particulate matter (PM), light/lighting, respiratory health

1054669

Random survival forests for predicting the interactions of multiple risk factors on all-cause mortality

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Abstract: While the associations between all-cause mortality and individual risk factors are well-characterized using e.g. Cox proportional hazards models, non pre-defined interactions between such factors and mortality risk are poorly understood. This study therefore aims to use random survival forests (RSF) as an automatized machine learning technique to detect, analyse and visualize complex interactions between individual risk factors. More specifically

we (1) study the associations between 27 physiological indicators and all-cause mortality, (2) identify the most important physiological and demographic indicators, (3) use RSF to predict mortality from the top five indicators, and (4) visualize the 6-dimensional interactions between age and these variables to understand their combined influence on mortality. We used data on 27 physiological indicators and demographics for 45,032 adults from the 1999-2014 NHANES Survey, linked with National Death Index mortality data through December 2015. In RSF settings, the predictor is an ensemble formed by combining results of many survival trees. Most important variables are selected based on their relative importance, defined as their predictive improvement compared to chance. We further calculated the hazard ratio (HR) by performing a Cox proportional hazards regression with the time to event and mortality status as outcome variables and the identified top indicators as predictors. In addition to age, the top 5 variables affecting mortality are the glomerular filtration rate (GFR), gender, glucose plasma, white blood cell count, and relative fat mass index, with a concordance of 70%. In addition to age, low GFR (< 70 mL/min/1.73 m2) strongly increases HR, for both old and younger people. In addition, HR increases when GFR is higher than 110 mL/min/1.73 m2 for males, aged 60 and 70, but not for 80 y/o. HR substantially increases for plasma glucose >110 mg/dL with a maximum at 150 mg/dL. There is an extremely strong effect in the elder population when white blood cell count is higher than 8 and GFR<70. The relative fat mass index has imited influence on mortality. A series of 36 heat maps enables us to simultaneously visualize the 6-dimensional interactions between the 5 top variables and age. While studying here the effect of physiological interactions on mortality, this RSF-based approach can incorporate other exposome risk factors to study how the interactions among exposures and physiology can influence mortality risk.

Keyword:multiple stressors, big data, other (specify below), machine learning

1054644

Exposure Load: Characterizing Concurrent Exposure to Multiple Chemicals Using Biomonitoring data from the Canadian Health Measures Survey

A. St-Amand, J. Willey, T. Pollock, E. Thomson, A. Maquiling, C. Liang, M. Walker; Health Canada

Abstract: Canadians are concurrently exposed to numerous chemicals that can vary both spatially and temporally in diverse environment. Biomonitoring data are indicative of real life chemical exposures from all sources and routes and offer a way to understand how chemical burdens may vary across a population. To quantify and assess multiple exposures, we developed the Exposure Load metric, which is defined as the number of chemicals measured above a defined threshold. This work uses nationally-representative data from the 2012–2015 Canadian Health Measures Survey (CHMS). The analysis considered 44 biomarkers representing 26 chemical groups, and included 1,858 participants aged 12 to 79 years. Participants were considered to be exposed to a chemical if at least one biomarker for a given chemical group was above a threshold. Specifically, each individual was assigned a value of 0 or 1 for each of the 44 biomarkers depending on whether that biomarker was measured below or above the concentration threshold, respectively. We calculated Exposure Loads based on five concentration thresholds: the analytical limit of detection (LOD), and the 50th, 75th, 90th and 95th percentiles. Most When considering the analytical limit of detection as the

threshold, most Canadians had an Exposure Load between 13 and 18. When considering the 95th percentile as the threshold, most Canadians had an Exposure Load between 0 and 3, although a small number of Canadians had Exposure Loads as high as 15. Adolescents aged 12–19 years had significantly lower Exposure Loads than adults aged 20–79 years. No differences in Exposure Loads were observed between males and females. Smokers had significantly higher Exposure Loads than nonsmokers, which was understandable given that tobacco smoke is a known source of some chemicals in our study. These findings indicate that Canadians are concurrently exposed to many chemicals at low concentrations and to fewer chemicals at high concentrations.

Keyword:biomonitoring, cumulative exposure, VOCs

1052529

Brief introduction into the assessment of occupational exposures to multiple exposures and chemical mixtures

J. Meyer, U. Schlueter; Federal Institute for Occupational Safety and Health (BAuA)

Abstract: Workers are exposed to a variety of stressors throughout their working lives. This includes contact to chemical mixtures, i.e. combinations of different chemicals, as well as multiple exposure to chemicals in combination with other stressors (e.g. noise, time pressure). These aspects lately gained importance in legal regulatory processes. The symposium aims to raise awareness of this topic in the scientific community and to contribute to a better understanding of the many complex factors and interactions. This presentation will be a brief introduction into the assessment of occupational exposures to multiple exposures and chemical mixtures and is intended to introduce the symposium participants to the topic. Briefly, it will be outlined whether and how exposure to chemical mixtures and multiple exposures have found their way into different European regulatory frameworks. Challenges related to exposure assessment to chemical mixtures and multiple stressors will then be discussed. These challenges can be addressed by new model and tool developments, which other speakers in the symposium will then present.

Keyword:occupational exposure, policy, other (specify below), chemical mixtures, multiple exposure, policy challenges

1025902

Precision environmental health monitoring by longitudinal exposome and multi-omics profiling

P. Gao, X. Shen, X. Zhang, M. Snyder; Stanford University

Abstract: Current environmental health studies mainly focus on limited stressors and populations, which failed to address the complex and personal nature of exposures. Here we longitudinally profiled personal exposome and internal multi-omics to investigate how the exposome shaped an individual’s phenome chronically for the first time. Thousands of chemical and biological substances were identified in the personal exposome cloud. We performed Spearman correlation analysis within the exposome and inter-omics analyses

between the exposome and gut microbiome, metabolome, and proteome, respectively. Furthermore, the exposome and multi-omics correlations were cross validated using clinical test results. Our results showed agrochemicals and fungi predominated in the highly diverse and dynamic exposome, and the individual's immune system, kidneys, and liver played essential roles in response to the personal exposome. Overall, our findings demonstrated that the exposome interacts with internal multi-omics dynamically and correlates with one's health status.

Keyword:environmental health, multiple stressors, microbial agents

1053630

Demonstrating a Systems Approach for Integrating Disparate Data Streams on Children's Environmental Health

A. Mullikin[1], E. Cohen-Hubal[1], N. DeLuca[1], J. Little[2], D. Reif[3], R. Slover[1]; [1]Environmental Protection Agency, [2]Virginia Polytechnic Institute, [3]North Carolina State University

Abstract: The use of systems science methodologies is increasing in order to understand complex environmental and human health relationships. Challenges with accessing appropriate data and modeling tools limits the application of this approach by environmental and public health practitioners. Furthermore, common statistical analyses can be difficult to employ and produce inconsistent results when using multiple data streams with different variable types as inputs. This study shows how basic systems science principles can be used to synthesize holistic insights for decision making using publicly available data and computational tools, focusing on a children's environmental health example. A simple conceptual model was developed for children in North Carolina counties that includes indicators of children's physical environment (Brownfield sites, Superfund sites, and homes built before 1979), social environment (children without insurance, head of household without a high school diploma, and children living in poverty), and health status (number of children discharged from the hospital due to asthma, babies born at a low birthweight, children with elevated blood lead levels). The online Toxicological Prioritization Index (ToxPi) tool's framework was used to normalize the data, rank the resulting vulnerability index, and visualize impacts from each indicator in a county as slices of a "pie." The 100 North Carolina counties were sorted into 5 groups through hierarchical clustering based on similar ToxPi charts and model results, giving insight into the factors that contribute to regional vulnerabilities. One cluster group shows that the percent of homes built before 1979 and the percent of children living in poverty are associated with an overall increase in vulnerability to the health outcomes, while another cluster group shows that the percent of homes built before 1979, percent of children living in poverty, and percent of household head without a high school diploma are associated with vulnerability to increased blood lead levels and low birthweight rates. The ToxPi charts for each county were also superimposed over a choropleth base map that shows percentage of each county's population under the age of 5 in order to visualize spatial connections between cluster groups and children-specific vulnerabilities.

Keyword:children, community, exposure factors

1001388
Engaging Multi-Sectors in Key Research Directions for Exposure Assessment: Five Years After the Lautenberg Amendments to the Toxic Substances Control Act
P. Koman; University of Michigan

Abstract: This presentation will discuss background on the TSCA exposure and risk evaluations and the relevance to exposure sciences. Key exposure science challenges arising from the amended law will be described as well as recommendations to better utilize the new U.S. authorities to promote health and advance social justice.

1001388
Joint effects of prenatal exposure to per- and poly-fluoroalkyl substances and psychosocial stressors on corticotropin releasing hormone during pregnancy
S. Eick; University of California, San Francisco

Abstract: Exposures to environmental chemicals (such as per- and poly-fluoroalkyl substances (PFAS)) and psychosocial stressors during pregnancy have been individually associated with adverse outcomes related to birthweight and gestational age. However, the joint prenatal exposures are not often considered in combination. This study examines the joint effects of prenatal exposure to PFAS and psychosocial stressors on corticotropin releasing hormone during pregnancy. Challenges in exposure assessment will be highlighted.

1001388
How can cumulative exposure assessment and inequality indicators contribute to anti-racist exposure science?
J. Levy; Boston University

Abstract: This presentation will describe how indicators for social inequity from other sectors can be used in exposure science. Case studies of cumulative environmental chemical exposures will be discussed along with the significance for advancing the field of exposure science toward anti-racist goals.

1001388
Innovative Approaches to Assessing Cumulative Environmental Exposures in Susceptible Populations
T. Woodruff; University of California, San Francisco

Abstract: This presentation will introduce data needs and requirements to improve the scientific basis, transparency and protection of vulnerable populations in cumulative environmental exposure frameworks. The role for exposure science and biomonitoring data from pregnant women will be featured. Policy implications of the science will be explored along with recommendations for the future of the Toxic Substances Control Act (TSCA).

1000485

Brief introduction into the assessment of occupational exposures to multiple exposures and chemical mixtures

J. Meyer; Federal Institute for Occupational Safety and Health (BAuA)

Abstract: This presentation gives a brief introduction into the assessment of occupational exposures to multiple exposures and chemical mixtures and is intended to introduce the symposium participants to the topic.

1000485

Estimating inhalation exposure resulting from evaporation of volatile multicomponent mixtures

M. Roitzsch; Federal Institute for Occupational Safety and Health (BAuA)

Abstract: For occupational risk assessments, often evaporation of volatile substances is of interest. A common example is the disinfection of surfaces by wiping. Models such as ConsExpo and ART can be used to simulate these processes. However, although these models are basically able to handle mixtures, the current implementations seem to be unable to correctly simulate concentration changes that actually occur in mixtures and in particular in thin films. This may lead to incorrect assessments of the exposure situations. More refined approaches for assessments will be presented.

1000485

Two-tiered model strategy for estimating inhalation exposure for spraying of liquid mixtures

J. Schwarz; Federal Institute for Occupational Health and Safety (BAuA)

Abstract: Exposure assessment for activities where liquid chemical mixtures are sprayed, is a frequently occurring case in risk assessment. Modelling approaches exist that consider individual aspects with relevance to mixture assessment. SprayExpo, for example, is applicable for estimating exposure to a non-volatile active substance in an evaporating solvent. We present for the first time an integrated strategy that aims to consistently consider liquid mixtures over the full range of volatility in both a screening and a more detailed assessment phase. The remaining limitations for both tiers will be discussed.

1000485

Assessing risks related to a mixture of chemical substances with the MiXie computer-based web tool

P. Sarazin; Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)

Abstract: During work, operators are often simultaneously exposed to multiple chemical substances. Many regulatory agencies or organizations, such as the American Conference of Governmental Industrial Hygienists (ACGIH®), prescribe that when several substances are present in workplaces and have similar effects on the same body organs, their contribution to the overall toxicity should be considered additive, unless established otherwise. This implies that even at concentrations lower than the occupational exposure levels (OELs) of chemical substances, the sum of their individual effects on organs could suggest a potential risk which would require prevention actions. The Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), the Université de Montréal, and the French Research and Safety

Institute for the Prevention of Occupational Accidents and Diseases (INRS) promote MiXie, a computer-based web tool that helps identify potential harmful effects of a mixture of substances on target organs. The algorithms employed groups toxicological effects associated with substances into toxicological classes, this allows to assess the potential additive effects of the mixture. In a previous work, an analysis of data from 30,000 work situations had shown that MiXie was able to identify almost 20% more potentially hazardous situations as compared to the single substance assessment approach. After the presentation of the MiXie methodology, a case study illustrating the use of MiXie and the benefits of taking into account multiple exposure will be presented. Even if other types of interactions than additivity (synergy, infra-additivity, etc.) are not included in its assessments, MiXie is a first step to help the industrial hygienist when facing a multiple exposure assessment situation. The MiXie software is available from http://www.inrs-mixie.fr/ (French version) and http://www.irsst.qc.ca/mixie/?en (Canadian version).

1000485

Exposure to chemical substances and other type of stressors in occupational settings: night work and noise.

F. Clerc; INRS - French Occupationnal Health and Safety Institute

Abstract: After a brief introduction presenting the ongoing research needs in France regarding the prevention of risks associated with multiple exposure, two studies will be presented. The first one proposes insights about the risks associated with the exposure to chemical substances and night or shift work. The second one is a data-driven study highlighting activity branches where the co-exposure to noise and ototoxic chemical substances is frequent. The results are correlated with occupational deafness.

OTHER

1054709

Using Social Security Number to Identify Sub-populations Vulnerable to the Health Impacts from Extreme Heat in Florida, U.S.

J. Jung[1], C. Uejio[2], T. Adeyeye[3], K. Kintziger[4], C. Duclos[5], K. Reid[5], M. Jordan[5], J. Spector[6], T. Insaf[3]; [1]Department of Environmental and Occupational Health Sciences, University of Washington, [2]Florida State University, [3]University at Albany, [4]University of Tennessee, [5]Florida Department of Health, [6]University of Washington

Abstract: Some socioeconomically vulnerable groups may experience disproportionately higher risk of extreme heat illness than other groups, but no study has utilized the presence/absence of a social security number (SSN) as a proxy for vulnerable sub-populations. This study focused on the warm season from 2008 to 2012 in Florida, U.S. With a total number of 8,256,171 individual level health outcomes, we devised separate case-crossover models for five heat-sensitive health outcome (cardiovascular disease, dehydration, heat-related illness, renal disease, and respiratory disease), type of health care visit (emergency department (ED) and hospitalization), and patients reporting/not reporting an SSN. Each stratified model also considered potential effect modification by sex, age, or race/ethnicity. Mean temperature raised the odds of five heat-sensitive health outcomes with

the highest odds ratios (ORs) for heat-related illness. Sex significantly modified heat exposure effects for dehydration ED visits (Males: 1.145, 95% CI: 1.137~1.153; Females: 1.110, 95% CI: 1.103~1.117) and hospitalization (Males: 1.116, 95% CI: 1.110~1.121; Females: 1.100, 95% CI: 1.095~1.105). Patients not reporting an SSN between 25 and 44 years (1.264, 95% CI: 1.192~1.340) exhibited significantly higher dehydration ED ORs than those reporting an SSN (1.146, 95% CI: 1.136~1.157). We also observed significantly higher ORs for cardiovascular disease hospitalization from the no SSN group (SSN: 1.089, 95% CI: 1.088~1.090; no SSN: 1.100, 95% CI: 1.091~1.110). This paper partially supports the idea that individuals without an SSN could experience higher risks of dehydration (for those 25-45 years), renal disease, and cardiovascular disease than those with an SSN.

Keyword:health disparities, health, other/general, case-crossover, Extreme heat

1093958

Occupational exposures from the lens of Occupational Health vs Risk Evaluation under the Lautenberg Chemical Safety Act

S. Maberti[1], E. Jensen[2], A. Maier[3]; [1]ExxonMobil Biomedical Sciences, [2]Dow Chemical Company, [3]Cardno ChemRisk

Abstract: Exposure assessment is key in the development of risk assessments. Industrial hygienists and environmental risk assessors have different purposes even though both need exposure estimates. Therefore, it is necessary to understand the objective of the assessment to develop a correct strategy or to correctly interpret and use the data. This presentation will provide a brief description of the strategy Industrial Hygienists follow to anticipate, recognize, evaluate, and control workplace hazards as an introduction to how exposures are estimated or quantified in the workplace, along the prioritization scheme used. This approach is the basis for how occupational exposure data is integrated and analyzed. This will be contrasted with the framework used by EPA to carry out risk evaluations. Understanding the advantages and limitations of each framework for exposure assessment is the key to select the optimal statistical and analytical approach for data interpretation. A simple set of criteria will be shared as suggestions on how to utilize occupational exposure data in the context of a risk evaluation as performed by EPA. In the case of large industrial settings, it is necessary to understand the controls already implemented in the workplace to properly assess exposures and identify the appropriate risk management measures to implement, in case there were a gap.

Keyword:industrial hygiene, occupational exposure, other (specify below), Risk Evaluation

1093965

Occupational Non-Users exposures from the lens of Occupational Health vs Risk Evaluation under Lautenberg Chemical Safety Act

E. Jensen[1], S. Maberti[2], A. Maier[3]; [1]The Dow Chemical Company, [2]ExxonMobil Biomedical Sciences, Inc, [3]Cardo ChemRisk

Abstract: In the industrial setting, the “Occupational Non-User” is typically an individual who, albeit not engaged in the activity involving chemical handling, is typically trained in the hazards associated with the plant and the operating procedures around them. Furthermore, it is important to mention that ONUs, do not typically spend all day in the same location, decreasing the potential for significant longer-term average daily exposures. Traditional controls implemented in the workplace (i.e., barricades when opening process equipment, or control of fugitive emissions) are considered sufficient to minimize potential exposures to bystanders. In the industrial setting, emissions tend to be controlled to minimize losses of material to the environment. Furthermore, practices are in place to prevent occupational exposures. Although exposures of ONUs are not typically measured in the industrial setting, their exposures are qualitatively assessed as controlled, since quantitative assessment of the highest exposures demonstrate these to be protective of potential workplace exposures. Case studies will be presented to showcase the calculations carried out to establish barricades, controlled entry zones, or select engineering controls, and to share examples of assessments done in the workplace to corroborate the effectiveness of such controls.

Keyword:industrial hygiene, occupational exposure, other (specify below), Risk Evaluation

1093971

Comparing and contrasting Risk Evaluation Frameworks and Reference Values

A. Maier[1], S. Maberti[2], E. Jensen[3]; [1]Cardno ChemRisk, [2]ExxonMobil Biomedical Sciences, Inc, [3]The Dow Company

Abstract: As discussed in the prior talks, the risk evaluation frameworks are different depending on the objective of the study. As described by NIOSH in their current intelligence bulletin: “NIOSH risk assessments follow the traditional NRC risk assessment steps except that NIOSH does not use the exposure assessment step...”. This approach does not consider exposures in the risk assessment because the objective is to derive “exposure levels that are safe for various periods of employment, including but not limited to the exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience.” The risk assessment results in a risk value (e.g., recommended exposure limit) that can then be applied for risk characterization considering scenario relevant exposures. Similar approaches are used by volunteer expert groups that establish occupational exposure limit guidelines. In contrast, the TSCA process develops toxicology or health effect based benchmarks as a point of departure for risk characterization and then assesses whether an adequate margin exists relative to a defined scenario or use condition. Although these processes have similarity in toxicological principles, there are also differences in the approach to considering temporal patterns of exposure and variability and uncertainty. With potential differences in the assessment of risk, how can we reconcile these approaches so that the potential risk is assessed, managed, and communicated correctly? This presentation will contrast alternative approaches and highlight the differences. This will provide the basis for a suggested path to align the environmental risk assessment as proposed by NRC and EPA to approaches typical for occupational exposures. Among the differences between the approaches to risk assessment and management is the criteria used to derive the occupational exposure limits and how

occupational exposure data are used to assess risk acceptability. Risk-based evaluations, like the one intended to be carried out under TSCA, must take into consideration not only the burden of disease in the population, but the common practices already implemented in the workplace. Only when considering applications in the context of likely and foreseeable scenarios, will an evaluation of the occupational environment reflect the potential burden of disease of the workers.

Keyword:industrial hygiene, occupational exposure, other (specify below), Risk Evaluation

1093717
Effects of Farming Techniques on the Degradation of DDT on Historic Cotton Farms
K. Barr, P. Panuwet, P. Ryan, E. Saikawa; Emory University

Abstract:p,p'-Dichlorodiphenyltrichloroethane (DDT) was a popular pesticide in the mid 20th century for commercial crop and livestock production. DDT remains in the environment for decades as either the original compound or its dechlorinated environmental metabolites p,p'-dichlorodiphenyldichloroethylene (DDE) and p,p'-dichlorodiphenyldichloroethane (DDD) which can bioaccumulate and translocate. Many studies have correlated these compounds (collectively referred to as DDX) with human health and environmental effects. DDX are xenobiotics that can disturb endocrine function resulting in infertility, pre-mature births, delayed sexual development, and other hormone-mediated effects in wildlife. Several studies have reported that the rate of degradation of DDT into its metabolites is affected by various farming practices, such as tillage, irrigation techniques, and the use of cover crops and fertilizers. Historical cotton farm soils likely have more DDX residue than the other soils because cotton farming uses 16% of all the insecticides, including historical use of DDT, worldwide. Georgia has been one of the major producers of cotton since the 19th century, thus is likely to have high levels of DDX. Therefore, in this study, we aimed to determine if different farming practices affect the decomposition of DDT in north Georgia farms that historically grew cotton. In this study, several Walton County farms were sampled for soil. The history of the land was recorded, and the soil levels of DDX were measured using gas chromatography-tandem mass spectrometry. Preliminary data demonstrate measurable levels of DDX in cotton farm soils with highly irrigated soils having slightly lower levels. Levels of DDE ranged from 45-132 pg/g with a median value of 97 pg/g with a 100% frequency of detection. DDT was less frequently detected but the DDT:DDE ratio suggested historic, not recent, use. Our data suggest a need to further research the effect of farming techniques on the degradation of DDT on farms that historically grew cotton.

Keyword:exposure factors, arsenic, pesticides

1054619
Novel task-based exposure factors to assess soil exposure among fruit and vegetable growers
S. Lupolt, K. Nachman; Johns Hopkins Bloomberg School of Public Health

Abstract: Background: Exposure to contaminants in soils may pose risks for agricultural

workers. Yet, the nature and extent of agricultural soil contact is poorly characterized, largely due to gaps in knowledge of agricultural worker time-activity patterns and behavioral factors. Objective: We aim to generate exposure factors describing how growers spend their time engaging in different tasks and investigate the impact of behavioral factors on soil exposure. Methods: We longitudinally administered a task-based soil contact activity questionnaire to 38 (rural, n=31; urban n=7) fruit and vegetable growers seasonally (i.e., in the spring, summer, fall and winter). We asked growers to estimate the frequency and duration of six common agricultural tasks and describe specific behaviors (e.g., use of PPE, clothing worn, tool use, ergonomic positioning, and handwashing practices) that may impact soil contact in the farming context. We also asked growers to estimate the amount of soil ingested on a typical day, calibrated against recommended ingestion rates from the US EPA Exposure Factors Program. Results: We generated novel exposure factors characterizing the frequency and duration of six tasks as well as self-reported soil contact, glove use and handwashing practices across and within tasks and seasons. For example, annual estimates (hrs/year) of tasks include: harvesting (range =19-768; median = 216); weeding (range = 3-867; median = 133); median =104); transplanting (range = 0-591; median = 43). Growers' self-reported estimates of soil ingestion suggest that mean estimates of soil ingestion from the US EPA Exposure Factors Program may underestimate soil ingestion for growers. Significance: Our study generated exposure factors as building blocks to build a task-based model for estimating soil exposure. We have also demonstrated the possibility and promise of this task-based approach for soil exposure assessment by deploying this method in a population highly exposed to soil. Our findings are helpful for designing more appropriate interventions to reduce soil exposure if needed and emphasize the need for additional research to quantify subconscious micro-activities. Furthermore, our findings suggest including additional pathways of pesticide exposure via ingestion of soil in risk assessments for pesticides may lead to more accurate estimations of chronic exposures and justify the consideration of non-applicator agricultural worker exposures in pesticide risk assessment.

Keyword:soil, exposure factors, activity patterns

1054622

The ability for tree barriers to reduce particulate matter concentrations and alter biological activity in human cells

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Abstract: Background: Ultrafine particles (<0.1 microns [UFP]) from traffic-related air pollution are a contributor to adverse health effects. For schools or homes close to busy roadways, exploring options to reduce UFP concentrations is a high priority. One emerging approach to reduce the impact of local sources of UFP on a micro (street) scale is the use of tree barriers. The purpose of our study, Trees Reducing Environmental Exposures (TREE), is to test the effectiveness of roadway tree barriers to reduce near-roadway UFP concentrations; and determine whether there is decreased reactivity of particulate mass on human small airway epithelial cells (SAEC). Methods: We selected five sites in the Atlanta, Georgia (USA) metropolitan area for monitoring that consisted of tree barriers, combination sound/

tree barriers and no barriers. We measured particle number concentration (proxy for UFP); PM2.5 and PM1 mass concentration; black carbon (BC) mass concentration; and UFP size distributions. In addition, we collected filtered samples of PM1 for compositional analyses and in vitro toxicology experiments using (SAEC). Sampling sites were located alongside Interstate-75/85 in Midtown Atlanta and Georgia-400 (mostly passenger vehicles); as well as Interstate-285 highway (large numbers of diesel trucks). Sampling took place in July through September 2020. Results/Conclusion: Here we report results from sites S1, S2 and S3. Mean concentrations (in particles/cm3) at sites S1, S2 and S3 were 17,710 (SD:17,813); 10,498 (SD:4,740); and 23,193 (SD:19,401), respectively. We found differences in UFP concentrations comparing monitors at the roadside and behind a barrier. On average there was a 21% reduction in UFP behind a tree barrier compared to readings at the roadside, however, specific reductions were 16%, 11% and 36%, for sites S1, S2 and S3, respectively. UFP size distributions were comprised of modestly smaller particles at the roadside, compared to behind the barrier. Preliminary in vitro toxicological analyses revealed that sites with tree barriers showed less UFP-induced impacts on oxidative stress and cytokine secretion, such as IL-8 and TNF-alpha, in SAEC. In conclusion, our results show a reduction in UFP concentrations associated with tree barriers along busy highways in Atlanta. Further, findings suggest that tree barriers may influence the biological activity of PM.

Keyword:exposure factors, sustainability, particulate matter (PM)

1054602
Improving Exposure Estimates in Urban Areas using a Multiscale Modeling Approach
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Abstract: Urban populations are exposed to air pollutant concentrations that have been linked to adverse health outcomes. Exposure assessments have widely used air quality measurements from regulatory monitoring stations. However, the spatial distribution of the monitoring stations cannot capture the spatial variations of pollutants at these urban scales. Additionally, short-term and long-term exposure to air pollutants results in distinct health outcomes requiring concentrations at a high temporal resolution collected over extended periods. One approach to address these limitations is to use modeled concentrations as an alternative to monitoring data. In this work, we evaluate the use of a multiscale modeling system for generating pollutant and exposure estimates at the urban scale. The Comprehensive Air Quality Model with Extensions (CAMx) provided estimates of pollutant concentrations at a regional scale (12 x 12 km resolution) for the Contiguous United States. CAMx results were further resolved using the Model for Air Pollution (InMAP) to yield higher resolution pollutant concentrations. The performance of the modeling system was evaluated by comparing the results with monitoring data provided by the EPA. Exposure estimates generated using monitoring data and modeling results were compared. The multiscale modeling system provided concentration estimates with an improved spatial coverage when compared to monitoring data. The system also provides concentrations with a high degree of spatial and temporal resolution, which is critical for accurate exposure assessments.

Keyword:air pollutants, air pollution, air quality, urban air pollution

1054649

Rapid Assessment of Indoor and Outdoor PM2.5 Air Pollution Levels and Determinants in Rural Jalapa, Guatemala

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Abstract: The effectiveness of previous intervention programs remains inconclusive primarily due to the inability of these trials to create significant exposure contrasts between the treatment and control group. Thus, there is a need for novel research study designs that can efficiently scope potential trial sites where complete adoption of the intervention would be expected to create a strong exposure contrast. As part of formative research for the Household Air Pollution Intervention Network (HAPIN) trial, we conducted rapid surveys in randomly selected homes in Jalapa, Guatemala. Gravimetrically adjusted real-time 15-minute average PM2.5 concentrations were collected in both kitchen and outdoor microenvironments during screening survey visits in a total of 394 households. We constructed linear mixed models to explain the variation of both kitchen and patio measurements by communities and the effect of current biomass cooking. To explore the spatial variation in concentrations, we employed a general additive model with a thin plate smoothing function with respect to the coordinates of the homes in the study. The GM (CI) for real-time kitchen cooking PM2.5 concentrations was 62 ug/m3 (53 – 73), while kitchen background concentrations were, on average, 76 (67 – 82) percent lower when no cooking event was observed. PM2.5 concentrations were 53 (47 – 59) and 77 (53 – 88) percent lower than kitchen cooking concentrations for outdoor measurements in homes with observed cooking events and without observed cooking events, respectively. We were able to show how the potential contrast in kitchen exposures may vary comparing biomass burning levels and background concentrations across communities. Using a thin plate spline we were able to show spatial variation in kitchen concentrations when no biomass burning was observed ($p = 0.007$, $df = 10$). Our findings support the selection of Jalapa as a study site for HAPIN. Using a rapid assessment survey in Jalapa, we were able to better understand the implications for potential exposure reduction, by assessing the relationship between PM2.5 concentrations and characteristics at the household and community level. In the context of planned household health surveys in LMICs, the additional application of cost-effective personal air monitors worn by technicians for short-term PM2.5 measurements can be a useful tool for screening the potential effectiveness of a clean cooking intervention on reducing HAP exposures.

Keyword:particulate matter (PM), fine particlate matter, air pollution

1054492

PERFORMANCE OF CHEMSTEER AGAINST FIELD MEASUREMENTS

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Abstract: Chemical Screening Tool for Exposure and Environmental Releases (ChemSTEER) is a tool that incorporates a set of release and exposure models. The tool provides models for inhalational and dermal pathway and for releases to air, water and soil. In this study, we compared the modelled estimates with measured occupational inhalation exposure from an independent database. The data included measurements collected between 2008 and 2012 in Switzerland (SUVA; Savic et al. (2017)) and in 2015 in the USA (NIOSH; Lee et al. (2019b); Lee et al. (2019a)). Around a thousand individual exposure measurements were used to evaluate accuracy, precision and regression parameters of the exposure models. In this presentation we will discuss the study results and identify areas where the models accurately captured occupational conditions and where room for improvement exists. Further, we will provide our analysis on why all models tend to overestimate low and underestimate high measured values.

Keyword:exposure models, air pollutants, occupational exposure

1054444

Human exposure to cadmium and anemia: A systematic review

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Abstract: Background: Animal studies have shown that cadmium exposure induces several adverse health-related effects, including damages in the hematopoietic system (e.g. anemia through hemolysis, iron deficiency, and insufficient erythropoietin production). However, in humans, the role of cadmium on anemia is not well established. Objective: To summarize the available evidence about human cadmium exposure and anemia. Methods: A systematic search was performed in the online databases Pubmed, Scopus, and Web of Science for literature published in English or Portuguese between 1 January 2010 and 29 April 2021. Eligible papers included human observational studies that directly measured cadmium levels and had anemia as the outcome variable. Studies including hospital-based samples were excluded. Quality of papers was assessed using the National Institutes of Health's Quality Assessment Tool for Cohort and Cross-sectional Studies and Case-controls. Results: Out of the 2 419 papers identified, 11 were included (eight cross-sectional, two cross-sectional nested case-control, and one case-control), comprising a total of 19 595 participants, of which more than half are just from one study. Regarding the seven papers only including children and adolescents: three showed that the mean cadmium levels of anemic participants were significantly higher than of non-anemic; two found that children with high blood cadmium levels had higher odds of having iron deficiency anemia, with one of the studies also showing that higher levels of urinary cadmium per gram of creatinine were associated with lower odds of iron deficiency anemia; and three did not find an association. One study that analyzed combined data from female adolescents and adults reported a high mean blood cadmium level

among participants with iron deficiency anemia. Lastly, regarding the other three studies only including adults, none found an association between cadmium levels and anemia. Conclusions: Our findings suggest that cadmium exposure may be associated with anemia in children, although the evidence is inconsistent. Moreover, studies with adults are lacking. Longitudinal human biomonitoring studies are needed to clarify the current knowledge about the effects of cadmium on the hematopoietic system.

Keyword:biomonitoring, metals, other (specify below), anemia

1054447

Exposure sources of mammary carcinogens and endocrine disruptors highlight opportunities for breast cancer risk reduction

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Abstract: Breast cancer (BC) is among the most prevalent cancer types in the US and the world, and a leading cause of cancer deaths. Given the prevalence and deadliness of this disease, identification of environmental risk factors is needed so risks can be reduced. One approach to characterizing cancer risk factors is to classify chemical exposures based on their likelihood of causing relevant biological effects, and then to identify probable sources of exposure. While many databases have classified chemicals based on genotoxicity, carcinogenicity, etc., it is far less common to catalogue chemicals based on their likelihood to cause specific cancers. Here, we assembled a list of 270 exposures that have been shown to induce mammary tumors in the 2-year cancer bioassay. In addition, we extended this list of chemicals that are likely to promote BC development based on their ability to disrupt endocrine signaling—specifically to activate the estrogen receptor or increase synthesis of estradiol or progesterone—for a total of 948 exposures. In order to better understand exposure risks, we categorized exposure sources of these chemicals based on reported and modeled presence in food, consumer products, pharmaceuticals, pesticides, and industrial processes, as well as their production volume and modeled median intake in the general population. 659 BC-relevant chemicals are found in consumer products and dietary sources, 135 of them mammary carcinogens (MCs), creating widespread exposure potential in the general population. Hundreds more chemicals are found in pesticides (470 BC-relevant, 81 MC), and industrial settings (432 BC-relevant, 112 MC), and thus pose a risk of high exposure in occupational settings. Finally, we found 70 BC-relevant (36 MC) chemicals that are active ingredients in pharmaceuticals, 14 (5) of which are in the Top 200 most-prescribed drugs in the US. This list of MCs and BC-relevant chemicals thus highlights many opportunities for BC risk mitigation through product reformulation and replacement with safer chemicals, consumer product labeling, drug risk/benefit considerations, and biomonitoring.

Keyword:chemical prioritization, environmental health, source control

1054409

Human exposure to lead and anemia: Results from a systematic review

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de Genética, Instituto de Saúde Ambiental, Faculdade de Medicina da Universidade de Lisboa, [3]Department of Public Health and Welfare, Finnish Institute for Health and Welfare (THL)

Abstract: Background: Mechanistic studies show that lead interferes with the hematopoietic system by inhibiting key enzymes, and increasing oxidative stress, leading to hemolysis. However, the effect of lead exposure on anemia development in human studies is inconsistent. This systematic review aims to summarize the available evidence regarding human exposure to lead and anemia. Methods: PubMed, Scopus and Web of Science databases were searched for published articles between 1 January 2010 and 29 April 2021, written in English or Portuguese. All cohort, case-control, and cross-sectional studies, conducted with humans, with a direct assessment of exposure to lead, and having anemia as outcome were included. Studies with a hospital-based sample were excluded. Study quality was assessed using the National Institutes of Health's Quality Assessment Tools for Cohort and Cross-Sectional Studies and Case-Controls, as appropriate. Results: The search yielded 2 419 records, and 28 papers were included (18 including only children, 9 only adults, and one both populations). Four papers had a case-control design, 22 cross-sectional, and two cross-sectional nested case-control. In total, data from 27 611 participants were considered. Of the 19 papers including children, 12 found a positive association between higher blood lead levels (BLL) and anemia. From these, 10 papers reported that children with anemia had higher mean/median BLL than those without, and five papers reported that children with anemia had higher odds of having high BLL (≥5 □g/dL or ≥10 □g/dL) than children without (one study only found this difference in children under 2 years old). Regarding the 10 papers including adults, only two found positive associations between exposure to lead and anemia. One paper reported a higher mean BLL in adults with anemia in comparison to those without, and the other reported higher odds of having anemia for participants with higher lead levels when analyzing erythrocyte lead levels, but not whole BLL. Conclusion: Lead levels seem to be associated with anemia, predominantly in children, which calls for efforts to minimize lead exposure during infancy to mitigate the burden of this disease. Additionally, human biomonitoring studies need to be routinely conducted to assess exposure and its effects over time.

Keyword:lead (Pb), biomonitoring, other (specify below), anemia

1054399

Call for research infrastructure for determining pharmacokinetic parameters

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Abstract: Biomonitoring is one of the important instruments in the exposure science. In order for utilise the biomonitoring data in risk assessment and management, pharmacokinetics (PK) modelling is essential. However, PK parameters have not been well developed for biomonitoring target chemicals. In order to obtain human PK parameters, a typical PK study requires a dose of a target chemical, ideally a stable isotope labelled reference substance. Unfortunately, it is often considered unethical by an institutional review board (IRB) to dose humans such chemicals with no potential benefit to participants. Subtraction or replacement

approach can be used but, especially for chemicals in personal care products, it is hard to avoid the exposure. In this presentation, the state-of-the-art research in pharmacokinetics of chemicals of personal use, its challenges and problems, some solutions and a future direction will be discussed.

Keyword:biomonitoring, PBPK Modeling, environmental health

1054371

Exposure to Air Pollutant Mixture and Gestational Diabetes Mellitus in Southern California: Results from Electronic Health Record Data of a Large Pregnancy Cohort

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Abstract: Background: Epidemiological findings are inconsistent regarding the associations between air pollution exposure during pregnancy and gestational diabetes mellitus (GDM). Several limitations exist in previous studies, including the lack of information on accurate GDM diagnosis, maternal co-morbidity, lifestyle, residential changes during pregnancy and the consideration of multiple air pollutants and particulate matter (PM) components simultaneously. Objectives: To evaluate the relationships between GDM and maternal residential exposure to air pollution, and the joint effect of the mixture of air pollutants and PM components. Methods: Detailed clinical data were obtained for 395,927 pregnancies in southern California (2008-2018) from Kaiser Permanente Southern California (KPSC) electronic health records. GDM diagnosis was based on KPSC laboratory tests. Monthly average concentrations of fine particulate matter<2.5μm (PM2.5), <10μm (PM10), nitrogen dioxide (NO2), and ozone (O3) were estimated using kriging interpolation of EPA's routine monitoring station data, while PM2.5 compositions (i.e., sulfate, nitrate, ammonium, black carbon and organic matter) were estimated using a fine-resolution geoscience-derived model. A multilevel logistic regression was used to fit single-pollutant models; quantile g-computation approach was applied to estimate the joint effect of air pollution and PM components mixtures. Results: In total, 42,970 (10.9%) GDM cases were identified. In single-pollutant models, we observed an increased odds for GDM associated with exposures to PM2.5, PM10, NO2 and PM2.5 compositions. The association was strongest for NO2 [adjusted odds ratio (OR) per interquartile range increase: 1.11, 95% confidence interval (CI): 1.09-1.13]. In the multi-pollutant model with kriging-based NO2, PM2.5, and PM10, the mixture effect on increased GDM risk was driven by NO2 (70%) among the three air pollutants. In the multi-pollutant model with PM2.5 compositions, the mixture effect on increased GDM risk was driven by black carbon (50%). The risk of GDM associated with air pollution exposure were significantly higher among Hispanic mothers, mothers in low-income neighborhoods, and overweight/obese mothers. Conclusion: This large cohort study found that exposure to a mixture of PM2.5, PM10, NO2, and PM2.5 chemical compositions was associated with increased risk of GDM. NO2 and black carbon PM2.5 contributed most to GDM risk.

Keyword:air pollution, particulate matter (PM), other (specify below), exposure mixtures;

gestational diabetes mellitus

1053572
Usage patterns of facial cosmetic products in Asia
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Abstract: Layering practices are widespread in Asia but limited data are available on cosmetics consumption by Asian populations. Moreover, Asia is composed of several populations that may have different usage patterns of cosmetics. These usage habits data are essential to perform safety assessments for specific populations. The aim of this study was to characterize facial skincare habits in 3 Asian countries through a web-questionnaire survey. The survey on the consumption of 11 product categories was performed in China, Japan and Taiwan. Women from 16 to 55 years old, supposed to be the main skincare products consumers, were recruited. They had to use at least 1 of the 11 product categories and were selected according to criteria of representativeness: age and region of residence. A total panel of 1,801 women were recruited: 601 in China, 600 in Japan and 600 in Taiwan. Data on frequency of use and order of application of skincare products were collected, as well as information related to the impact of COVID-19 on cosmetic consumption habits. Among the 11 cosmetic product categories investigated, 9 are used by more than 57% of the respondents but with disparities between countries. In China, 43% of the participants use all the 11 product categories, compared to 23% in Taiwan and 8% in Japan. Chinese use an average of 8.7 categories, Taiwanese 7.7 and Japanese 6.9. Percentages of users are similar between the countries for cleanser, tonifier and sunscreen, whereas for the other categories differences over 10% are observed. The facial mask is used by 86% of Chinese, 79% of Taiwanese and 40% of Japanese. The eye contour is used by 72% of Chinese, 46% of Taiwanese and 25% of Japanese. The number of product categories used at least once a day also varies between the 3 countries: Chinese use an average of 6.6 categories daily, Taiwanese 5.4 and Japanese 5. Regarding the impact of COVID, 48% of the subjects in Japan report a change in cosmetic consumption habits, 40% in China and 18% in Taiwan. This study provides new cosmetic consumption data for 3 Asian populations and highlights disparities between China, Japan and Taiwan particularly for the number of product categories used daily. This suggests that layering could be different between these countries. Specific rituals might be identified by analyzing frequencies of use and order of application. All the information collected will help to create a more suitable database on facial skincare habits for these populations.

Keyword:consumer and personal care products, risk assessment, other (specify below), Asian populations

1052902
Disparities in Arsenic Exposure in the 2019 California Regional Exposure Study, CARE-2
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Abstract: Background: National biomonitoring data show consistent disparities in heavy metals exposure by race/ethnicity, with urinary arsenic being particularly high in the Asian population. Biomonitoring California conducted a quota-based regional surveillance study in five eastern and southeastern California counties in early 2019. The racial/ethnic breakdown of the 359 participants generally reflected that of the underlying population, with most participants identifying as Hispanic/Latino or non-Hispanic white, and fewer identifying as Black and Asian. Participants completed a questionnaire and gave blood and urine samples. Total arsenic concentrations were measured in the 357 urine samples collected. Objectives: We sought to identify demographic trends and potential sources of arsenic exposure in the CARE-2 study population. Methods: We used linear regression to assess the individual associations of demographic and exposure source factors with log-transformed urinary total arsenic concentrations, controlling for creatinine. We used backwards selection to identify the most predictive demographic variables and controlled for them when assessing potential exposure sources. Results: The geometric mean creatinine-adjusted urinary arsenic concentration was 8.04 μg/g (95% CI, 7.27, 8.88). Sixteen participants had concentrations at or above the Biomonitoring California level of concern for total arsenic (50 μg/L). Race, birthplace, and age were all significantly associated with arsenic levels when modeled individually. Concentrations increased 7.5% per decade of age. Asian participants had 116% higher arsenic concentrations than non-Hispanic white participants. Participants born in Asia had 123% higher concentrations than those born in the US. Age and birthplace were the most predictive demographic variables. Among the potential exposure sources that we assessed, seafood and brown rice consumption were significantly associated with arsenic concentrations. Conclusion: Our data show disparate exposures to arsenic in Asian communities in eastern and southeastern California. Seafood and brown rice may be important sources of exposure. This is the first biomonitoring surveillance study to focus on the population of this region. These findings are consistent with studies done in other parts of the state and highlight the need to address disparate exposures to environmental contaminants across California.

Keyword:biomonitoring, arsenic, exposure factors

1052768

How Exposure Sources, Data and Models Influence Human Health Risk Assessments Under Canada's Chemicals Management Plan – A Look at Recent Trends

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Abstract: Under the Government of Canada's Chemicals Management Plan (CMP), numerous screening assessments for existing chemicals have been published, for which human health risks have been identified. Various sources of exposure, utilizing both measured and modeled data, are used to inform these assessments. Exposure scenarios also consider different sub-populations, ranging from infants to adults. The sources of exposure, approaches to estimating exposure, and the exposed sub-population can have an influence on the overall human health risk associated with a substance. An overview of exposures estimated for the general population in Canada to a wide range of chemicals recently published under Canada's CMP (2020-present) will be presented. The analysis will focus on exposure sources including environmental media (e.g., drinking water, indoor and ambient

air, soil, and dust), food and food packaging, and products available to consumers (e.g., self-care products, household cleaners, do-it-yourself products). The analysis will highlight trends in human health risk issues based on these sources of exposure. In addition, the types of exposure models and algorithms used to support exposure estimates will be discussed. An examination of sub-populations considered for exposure estimates will also be presented.

Keyword:risk assessment, consumer and personal care products, ecological exposure

1053857

Unequal Response, Unequal Protection: Designing a Comprehensive Response to Health Concerns Related to Widespread Chemical Exposure

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Abstract: The federal government has comprehensive protocols in place to protect public health in cases of infectious disease, foodborne illness, and natural disaster. However, no such protocols exist in the case of widespread chemical exposure. When communities have been exposed to toxic chemicals, they were not always met with investigative resources or large-scale agency mobilization. The absence of uniformly applied, comprehensive protocols leads to health injustice: unequal responses to widespread chemical exposure result in unequal protection of communities' health. Those most likely to be affected are often those least likely to have the political, social, or economic capital to change this system. The public health response to widespread chemical exposure must be reimagined in order to end these disparities and fully protect public health. The Center for Health, Environment and Justice (CHEJ) is a nonprofit organization that has spent 40 years helping communities exposed to toxic chemicals fight to protect their health. Through our work we've seen the consequences of not having comprehensive protocols in place: slow responses, inadequate or inconclusive studies, incomplete cleanup of dangerous sites, communities facing cumulative effects of multiple chemical exposures, and little oversight to prevent future exposures. These deficiencies are common even when data shows that communities have been exposed to unsafe levels of chemicals. In collaboration with community leaders and public health scientists, CHEJ has spent the last year developing a framework for a comprehensive response for investigating health concerns related to widespread chemical exposure. We began by holding meetings with community leaders from across the country who have dealt with chemical exposure and the inadequate responses to it. We discussed what they felt a successful response would include and drafted a just, community-focused model. We then met with health professionals to solicit their expertise on how this program might best work and incorporated their input. This partnership between community leaders and public health professionals has led to a new public health investigative model for responding to widespread chemical exposure. This model prioritizes engaging the community throughout the investigative process – from information gathering to hypothesis generation to data analysis – to comprehensively and equitably protect them from health effects of widespread chemical exposure.

Keyword:community, environmental justice, health disparities

1053927

Racial/ethnic PFAS disparities in California regional biomonitoring

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Abstract: Perfluoroalkyl and polyfluoroalkyl substances (PFASs) have been widely detected in the environment, food, drinking water, and indoor dust, and are associated with adverse health effects. To characterize general population exposures to environmental chemicals including PFAS, Biomonitoring California has conducted two regional surveillance studies in (1) Los Angeles County in 2018 (CARE-LA) and (2) five eastern and southeastern California counties in early 2019 (CARE-2). The racial/ethnic breakdown generally reflected the underlying population, with most participants identifying as Hispanic/Latino (36% in CARE-LA and 47% CARE-2), non-Hispanic white (30% and 37%), or Asian (16% and 6%). Serum samples were collected from 425 participants in CARE-LA and 358 participants in CARE-2 and analyzed for 12 PFASs by liquid-liquid extraction high-performance liquid chromatography tandem mass spectrometry. We performed multivariable linear regression to identify demographic factors associated with increased exposure. Geometric means of PFASs detected in almost all participants were as follows: perfluorooctanoic acid (PFOA) concentrations were 1.05 ng/ml [95% confidence interval (CI), 0.97- 1.12] and 0.98 ng/ml (95% CI, 0.90, 1.1) for CARE-LA and CARE-2, respectively; perfluorooctane sulfonic acid (PFOS) concentrations were 2.13 ng/ml (95% CI, 1.92-2.36) and 2.40 (95% CI, 2.17- 2.65); and perfluorohexane sulfonic acid (PFHxS) concentrations were 0.614 ng/ml (95% CI, 0.56, 0.67) and 0.78 (95% CI, 0.70, 0.87). Overall PFAS concentrations trended lower than overall US values observed in 2017-2018 National Health and Nutrition Examination Survey (NHANES) data. Racial/ethnic differences were apparent with Asians highest in 5 of the 6 PFAS with detection frequencies over 65% (PFOA, PFOS, PFHxS, perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDeA). After adjustment for age and gender, PFOS concentrations were 1.7 times higher in Asians than in Whites in both studies. PFDeA concentrations were 1.3-1.8 times higher. Hispanics had consistently lower levels of the same 5 PFAS, approximately 20% lower than Whites. Concentrations of 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid [Me-PFOSA-AcOH] followed a different pattern highest in Blacks and lowest in Asians. These findings illustrate the differing landscape of PFAS prevalence and the need for better understanding of underlying exposures that lead to disparate PFAS body burdens.

Keyword:biomonitoring, PFAS, concentration

1054031

Concentrations of Blood and Urinary Arsenic Species and their Characteristics in Korean General Population

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Abstract: Background/Aim: Arsenic (As) is a ubiquitous metalloid and exists in the form of

inorganic (iAs) and organic compounds (oAs). In particular, iAs is the priority pollutant considering its toxicity. The urinary species are considered as biomarkers of exposure to As – arsenate (As(V)), arsenite (As(III)), monomethylarsonic acid (MMA), and dimethylarsinic acid (DMA), etc. Interestingly, limited information is available on the biomarkers in blood. Also, there have been many population studies in highly contaminated region compared to general population. The aims of the present study are to measure and characterize the As species in matched pairs of blood and urine among general Korean populations. Methods: The Korean Ministry of Food and Drug Safety (MFDS) collected the biological samples (n = 2,049) among Korean general population (aged from 1 to 98) from 2017 to 2018. We took 2,025 samples of urine and 598 samples of blood, and the urine-blood pairs were matched considering the age and sex distribution of the entire study population. High-performance liquid chromatography with inductively coupled plasma mass spectrometry (HPLC-ICP-MS) was used to measure six arsenic species – As(V), As(III), MMA, DMA, arsenobetaine (AsB), arsenocholine (AsC). Results: The levels of As species in urine and blood were associated with age. Specifically, AsB and DMA were the most abundant species; the contents of iAs decreases with increasing age. From the multivariate linear regression analysis, seafood intakes were associated with increased AsB and DMA levels in both urine and blood. Interestingly, the composition ratio of iAs was higher in blood than in urine while the oAs's (particularly DMA and AsB) was opposite. Between urine and blood, there were moderate correlation in AsB ($\rho = 0.56$, $p < 0.001$) and weak correlations in MMA ($\rho = 0.15$, $p < 0.01$) and DMA ($\rho = 0.26$, $p < 0.001$), but not in iAs ($\rho = 0.08$). Conclusions: Suggestively, blood is a considerable media reflecting internal exposure to iAs specifically; blood might show different time windows of exposure compared to urine although further studies are required to confirm.

Keyword:biomonitoring, biomarkers, arsenic

1054260

Time-dependent excretion of glyphosate in urine of Thai agricultural workers

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Abstract: Background: Glyphosate is one of the most widely applied herbicides in the world for controlling weeds and grasses. Human exposure to glyphosate is widespread, but its toxicokinetics in humans is not currently well understood. In particular, the excretion profile of glyphosate in urine has not been well defined with only a few studies with limited

participants published. Moreover, results from studies on the human health outcomes associated with glyphosate exposure are contradictory, likely owing to the limited capacity to characterize the exposure fully. Objective: This study aims to monitor the time-dependent excretion of glyphosate in urine from Thai farm workers who routinely apply glyphosate in agricultural fields. Method: A total of 15 Thai male farm workers who applied glyphosate were enrolled from two locations in Chiang Mai province, Thailand. Serial spot urine samples were collected from each participant prior to application and for up to 60 hours following application. Field blanks were also collected to evaluate possible contamination of residual glyphosate from the fields. Each participant provided between 4-18 urine samples. All urine samples were analyzed for glyphosate using a fully validated GC-MS method. Creatinine levels were measured using an LC-MS/MS method. Results: Glyphosate and creatinine-adjusted glyphosate concentrations were plotted against the sample collection times. Most of the participants' glyphosate levels peaked around 5 hours and returned to their baseline concentrations approximately 15 hours after exposure. A third of the participants had another spike in glyphosate levels between 25-40 hours post-exposure, suggesting a biphasic excretion pattern. Conclusion: This study provides insight into the time window that urine samples should be collected for accurate exposure assessment. Additionally, our data confirmed the biphasic excretion pattern that has been documented before. While these data are from occupational exposure and may not be generalizable to non-occupational settings, they provide important information toward further understanding the toxicokinetics of glyphosate in humans.

Keyword:pesticides, metabolism, biomonitoring

1054085

A participatory approach to assess children exposure to black carbon in Milan, Italy: spatial analysis, personal measurements, and possible mitigation actions

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Abstract: Air pollution is a global threat to public health, especially if considering susceptible populations. The first global conference on air pollution highlighted the need to "strengthen action to protect the most vulnerable populations, especially children" and to "enhance education on air pollution as a key factor for improving health and quality of life". The aim of this contribution is presenting the results of a two-years participatory-based research focused on exposure of children aged 9-10 years to equivalent black carbon (eBC). The multi-step process consisted of: (a) modelling spatial distribution of eBC in a school catchment area; (b) engaging teachers, children, and their families in the process; (c) assessing personal exposure of children; (d) validating the spatial models by using personal exposure data. Concerning step (a), the participatory approach helped to identify a relevant number of potential monitoring sites proposed by residents, among which it was possible to find the final set. The consequent spatial analysis showed morning rush hour as the most critical daily time window for eBC, with higher increases in concentrations at traffic sites. For step (b), 128 children were involved in a multitude of playful activities on the topic of air pollution. Six posters on

the Sustainable Development Goals were drawn up and exhibited in a public event inside the school. This experience helped us at engaging children, teachers, and their parents in the following steps. In step (c) 109 children were asked to wear a GPS and a micro-aethalometer to measure eBC. The highest peaks of exposure were detected during the home-school commute. Children received most of their daily dose at home and school (82%). Linear mixed-effect models showed meteorological variables as the most influencing predictors, but total time spent in a car, duration of the home-school commute, and smoking habits of parents were important predictors as well. In step (d) personal exposure data showed good agreement with spatial model estimates (Pearson's r = 0.74, Lin's Concordance Correlation Coefficient = 0.6), allowing us to identify the cleanest routes to school. This experience showed the potential of a participatory approach in the framework of exposure science. Our results highlight that mobility issues are among the most important challenges to reduce personal exposure of children in the city of Milan and home-school mobility planning a possible effective mitigation action.

Keyword:activity patterns, children, air pollution

1026239

Health risks of inhalation exposure particle-bound heavy metal(loid)s in Hong Kong adult residents

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Abstract: Heterogeneity between ambient and personal exposure to heavy metals has been reported. However, few studies have investigated potential health risks posed by inhalational exposure to airborne heavy metal(loid)s at the individual level. Four hundred four personal fine particles (PM2.5) samples were collected from 61 adult residents (aged 18–63 years) in Hong Kong during 2014–2015. Heavy metal(loid)s were analyzed using Energy Dispersive X-Ray Fluorescence. Among the target heavy metal(loid)s, zinc (Zn) was the most abundant component in personal PM2.5, followed by lead (Pb), copper (Cu), and vanadium (V). Health risks of heavy metal(loid)s via inhalation were assessed for adults, including non-cancer risks that were characterized by hazard quotient (HQ) and hazard index (HI). The results indicated that non-cancer risks of heavy metal(loid)s were attributable to Cu, with a 95th HQ value > 1. Arsenic (As) and hexavalent chromium [Cr (VI)] were also significant contributors to inhalation cancer risks (> 1 × 10-6) for the adult participants. Finally, we employed a Monte Carlo simulation to assess the uncertainly associated with health risk assessment. The mean and median upper-bound lifetime inhalation cancer risk associated with exposure to carcinogenic heavy metal(loid)s exceeded the acceptable level (1 × 10-6) for adults. Traffic emission (including non-tailpipe exhaust), shipping emission, and regional pollution were significant sources of heavy metals. The findings suggest that emission controls targeting local vehicles and vessels should be given priority in Hong Kong.

Keyword:hazardous air pollutant (HAP), cumulative exposure, health impact assessment (HIA)

1044518

Exposure Measurement and Systematic Review of Environmental Epidemiology Studies

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Abstract:BACKGROUND: Systematic review methodology is used to draw conclusions from existing evidence, while considering sources of bias in studies selected from the published literature. Evaluating bias from exposure measurement error in epidemiology studies may require integration of specialized expertise from multiple disciplines. We developed a set of criteria for the evaluation of total mercury and methylmercury measurements in hair and blood in epidemiologic study populations, drawing on expertise in the areas of both analytical chemistry and epidemiology. METHODS: As outlined in the systematic review protocol made public before conducting evaluations, exposure measurements for each cohort were assigned ratings of good, adequate, deficient, or critically deficient based on the analytical method details (e.g., oxidizing and reducing reagents, internal standards) and quantitative metrics of method performance (e.g., coefficients of variation, percent recovery, comparisons of measured and target values for certified reference materials). When exposure measurements were conducted using more than one method or sample type, separate ratings were assigned for each method and type. Evaluations were conducted for every cohort by three independent reviewers, two analytical chemists and one epidemiologist, and discordant review results were resolved through discussion until agreement could be reached among all reviewers. For each cohort, corresponding authors were contacted to request additional information if exposure measurement methods were not described in sufficient detail to apply our evaluation criteria. RESULTS: Out of 82 cohorts evaluated, authors were contacted for 52 (63%) of the cohorts, and of those who were contacted, 31 (60%) responded. Based on method details in the published literature or provided upon request, 43 (52%) of the cohorts received a rating of good or adequate for at least one measurement method and 39 (48%) cohorts received no rating above deficient or critically deficient. CONCLUSIONS: Our evaluation criteria illustrate one approach for incorporating exposure sciences expertise in the area of biomarker measurement and analytical chemistry into a systematic review of epidemiologic evidence. The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Keyword:mercury, epidemiology, biomarkers

1046518

Unexpected reduction in airborne Pb at a regional airport following runway shortening that reduced large and medium jet traffic

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Abstract: In December 2017, the runway at Santa Monica Airport (SMO), a general aviation airport in Southern California that supported >25,000 operations annually, was shortened from 1500 to 900 m via a consent decree between City of Santa Monica and FAA. This shortening in effect eliminated large and medium turbine aircraft, such as jets, that use unleaded fuel Jet-A. Total operations decreased >50% post-shortening and the share of

medium or higher weight aircraft in total operations changed from nearly 50% to just 9%, and the share of jet engine in total operations dropped from 63% to 25%. We investigated whether these reductions in operations and changes in aircraft fleet mix resulted in improved air quality in a downwind neighborhood just east of the airport. Air pollutants (ultrafine particle number concentration [PNC], black carbon [BC] and lead (Pb) in PM2.5) were monitored during four distinct periods: pre-shortening, during a complete operational shutdown, immediately following resumption of operations on the shortened runway (but at a depressed flight activity level), and a year later when flight activity had rebounded to new typical levels. Monitoring was conducted at two locations: a runway site (276 m downwind from the shortened runway), and a residential site (362 m downwind). Post-shortening, immediately after the resumption of operations, PNC were 75% lower than pre-shortening at the runway site and 36% lower at the residential site; BC concentrations were 30% lower than pre-shortening at the runway site but 25% higher than pre-shortening at the residential site. These reductions were sustained and one year later the concentrations continued to be substantially (and statistically significantly) lower. Operations of piston engine planes, which use leaded aviation gas (AvGas), changed minimally due to runway shortening (total operations were 4500 in 2017 and 4800 in 2018-2019). Nonetheless, post shortening and even one-year-later, the concentration of Pb was still 75% lower than pre-shortening at the runway site (24 to 6 ng/m3); concentrations at the residential site were similar to the runway site. It appears that jet-induced resuspension of leaded particulate matter (as opposed to direct emissions) contributed significantly to the airborne Pb concentrations in the area. If so, dust resuspension mitigation at regional airports may be an important Pb reduction measure in addition to the anticipated banning of the use of AvGas.

Keyword:air quality, lead (Pb), public health, Ultrafine, aviation emissions, black carbon

1052558

Systematic Review on the Health Effects of Long-term Exposure to Traffic-Related Air Pollution

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Abstract: Health effects of traffic-related air pollution (TRAP) continue to be of public health interest across the globe, with highest exposures in urban settings and residences in proximity to busy roadways. TRAP is a complex mixture, characterized by high spatial and temporal variability that has changed over time and by country. Since a previous extensive review of TRAP by the Health Effects Institute (HEI) in 2010, many additional studies investigating the health effects of exposure to TRAP have been published. Furthermore, air quality regulations have been tightened and vehicle technologies have advanced. In addition, there is a better appreciation of the complex interactions between socioeconomic status, inequalities in exposure and health burdens, and traffic noise in health studies of TRAP. HEI and an Expert Panel have conducted a new systematic review of the epidemiological literature on the health effects of long-term exposure to TRAP, the largest systematic effort to date. Results were combined quantitatively and may be useful for future risk and health impact assessments. After a broad search, the Panel identified 1100 studies relevant for further screening; 352 of

which met the inclusion criteria and are considered in the systematic review. Respiratory effects in children (N=117) and birth outcomes (N=86) were the most common outcomes published in the literature. Slightly fewer studies investigated cardiometabolic effects (N=57), respiratory effects in adults (N=50), and mortality (N=49). The systematic review is currently undergoing independent peer-review and publication is aimed for late 2021. The initial findings from the meta-analyses supplemented with additional analyses and evaluation of potential biases, provided a high level of confidence in an association between TRAP and all-cause mortality, circulatory mortality, ischemic heart disease mortality. The confidence in an association was moderate to high between TRAP and lung cancer mortality, asthma onset for both children and adults, and acute lower respiratory infections in children. Confidence was lower for several cardiometabolic outcomes and birth outcomes. We will present the main findings of the systematic review, and discuss the evidence base of TRAP and selected health outcomes with an emphasis on the exposure assessment strengths and needs for future work. The new review will be an authoritative update of HEI's most-cited report for use by researchers and policymakers.

Keyword:air pollution, epidemiology, other (specify below), traffic

1052614

Main determinants of in-vehicle exposure to traffic-related air pollutants: a decade systematic review

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Abstract: The study of in-cabin micro-environments is fundamental to defend both the drivers' and passengers' health. The present investigation consists of a decade (2010-2020) systematic review of the literature about the main determinants of in-vehicle exposure to traffic-related air pollutants (TRAPs). A total of 58 studies are included in the review. This work has considered the following types of vehicles: passenger cars, taxis, buses, vans, and trucks. Several chemical contaminants are examined: particulate matter, ultra-fine particles, black carbon, nitrogen oxides, carbon monoxide, carbon dioxide, ozone, sulfur dioxide, polycyclic aromatic hydrocarbons, and Volatile Organic Compounds. A first interesting topic regards the instrumentation type: 87% of the instruments used in the considered researches referred to direct-reading instruments and only 13% referred to time-integrated techniques. This difference is probably related to the fact that the cabin environment is characterized by high temporal (and spatial) resolution. Therefore, using real-time instruments is possible to measure and characterize short-term concentration profiles during the driving time, especially considering that concentration peaks, in general, should last for a short period of time. The determinants are grouped into seven categories: ambient conditions and meteorological parameters, passengers' activities, route characteristics, time-related variables, traffic factors, vehicle factors, and ventilation settings. As expected, this last factor was analyzed in most of the selected papers because it is essential to control the in-cabin exposure. In fact, it is the main determinant that also controls the influence of other factors such as traffic conditions and vehicle characteristics. As regard traffic conditions, this study highlights the importance of the leading vehicle emissions. This factor was analyzed in-depth only in one research, but several studies have explained high in-cabin concentration levels with the presence of high

emitting vehicles ahead. It's important to delve into this factor using a dedicated statistical analysis (e.g., analysis of variance). In conclusion, the present work summarizes and discusses the main determinants that affect the in-cabin exposure to a combination of TRAPs or to a single TRAP as well as inside specific types of vehicles. Furthermore, it provides advantageous insights and it may be useful to plan future in-cabin exposure assessment studies.

Keyword:exposure factors, air pollutants, ventilation

1049011

Proposing a Strategy for Exposure Science in Europe 2020-2030

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Abstract: Exposure information is a critical element in various regulatory and non-regulatory frameworks in Europe that aims to ensure safe environments, reduce human health risks and foster a sustainable future. The diversity of exposure information requirements across European legislation, an increasing number of data generation initiatives, and ambitions for more realistic assessments at the complex chemical-product-environment-health nexus create unique demands for exposure science. A long-term strategy is required to continuously identify exposure science knowledge gaps and limitations, which currently hamper policy uptake and define operational ways to advance exposure science, education and policy uptake, harmonise information requirements, and consider global societal trends and funding options. In response to the need for a strategy to advance exposure science in Europe, the Europe Regional Chapter of the International Society of Exposure Science established six dedicated working groups; Exposure models; education, training & communication; Exposure data production: Human data; Data repositories & analytics and Integrated Frameworks & Policy Efficiency. These working groups discussed crucial needs, activities and research needed under long-term programmes to contribute to the 'European Exposure Science Strategy' 2020-2030 roadmap, in line with rapid advances in science and technology, for the advancement of exposure science knowledge and increased uptake into European legislation. The strategy will identify requirements and provide a pathway for promoting the use of exposure information for regulatory purposes across health and safety, security and sustainability, for harmonised terminology, building a consistent exposure science curriculum, advancement and improvement of modelling principles and tools, advancement of exposure data analytics and repositories, promotion of the use of human biomonitoring data to improve regulatory risk assessment and an industry's perspective on exposure science priorities. An overview of the developments towards a European Exposure Science Strategy will be presented, including objectives, requirements and next steps. These results will describe exposure science's role for the future in Europe, its connection to research excellence and related funding options, industrial innovation and citizen science to support public health, consumer and worker safety, and environmental protection across science and policy fields.

Keyword:policy, environmental regulation, environmental policy, models, human biomonitoring, education, data repositories

977693
A review of dispersion models in exposure assessment and a case study in New York tri-state area
X. Zhang; Icahn School of Medicine at Mount Sinai

Abstract: The first part of this presentation will review the contribution of dispersion models in estimating ambient concentrations of air pollution. The second part of presentation will be a case study of modeling NO2 using line-source dispersion model (RLINE) in New York tri-state area.

977693
Dispersion modeling in support of risk assessments for air toxics
M. Woody; US EPA

Abstract: This presentation will detail how EPA utilizes dispersion modeling in its risk assessments for air toxics. These risk assessments fulfill requirements under the Clean Air Act and inform policy decisions.

977693
An Environmental Data Web Service Based on Near-Road Dispersion Modeling to Support the Los Angeles Pediatric Research Integrating Sensor Monitoring Systems (PRISMS) Informatics Center
S. Chang; Sonoma Technology

Abstract: The presentation will focus on an environmental data web service that provides real-time weather, air quality, and traffic-related air pollution data streams to support pediatric asthma research and to support smartwatch/smartphone applications that will provide real-time context-based information and alerts to help children avoid asthmatic incidents.

977693
Estimating traffic-related air pollution in urban scale using a hybrid dispersion model
M. Wang; University at Buffalo, SUNY

Abstract: The presentation will focus on the development of a hierarchical modeling framework that combines line-source dispersion model, satellite observations and geographical variables for urban-scale spatiotemporal air pollution predictions. We will provide systemic evaluation on the performance of the hybrid model and the values of dispersion model predictions for urban-scale epidemiological study.

1001440
Overview and Introduction to the Unsolved Issues in Green space Exposure Assessment

M. Jerrett; University of California, Los Angeles

Abstract: The talk will introduce the symposium and focus on past approaches, while also highlighting key unresolved issues in the field, including: spatial and temporal resolution of exposure metrics; quality assessment; time-activity modeling in relation to exposure; the use of ubiquitous sensors; and finally the availability of high-resolution satellite products and machine learning methods to improve the classification of green space. In addition, some discussion of how appropriate exposure assessment may depend on the population studies (e.g., adults vs. children) and the health activity or outcome (e.g., physical activity vs. depression). The introduction will also briefly situate the four research talks in the broader advances occurring in the field.

1001440
Characterizing green space exposure for epidemiological studies: moving from 2D to 3D indicators
P. Dadvand; Barcelona Institute for Global Health (ISGlobal)

Abstract: This study has developed novel LIDAR-based indicators of green and gray spaces including 3D indicators (instead of 2D indicators that have been used so far) such as Green volume [m3/ha] defined as volume of green features (e.g. shrubs, trees, etc), Gray volume[m3/ha] defined as volume of buildings, and Normalized Difference Green/Gray Volume index, a novel holistic indicator of the balance between green and grey volumes as well as other indicators such as height of trees. We have applied these measures to a large population-based cohort in Rome, Italy, and have compared these 3D indicators with 2D indicators (such as Normalized Difference Vegetation Index) that have been extensively used in the epidemiological studies of the health effects of green spaces so far.

1001440
Global Positioning System (GPS) Assessments of Green Space Exposure and Use.
J. Lipsitt; UCLA

Abstract: We use stand-alone and cell-phone application measures of geographic location at 10 second intervals to assess exposure to green space. The study relies on two major field collections: (1) the Health Places study with 637 parent-child dyads measured repeated over 4 years; and (2) the PASTA LA study which measured 441 participants with both commercial GPS and cell-phone apps. We characterize the activity space for all participants using a 95% ellipse of their GPS traces to assign exposure in combination with high-resolution 0.6 m assessments of normalized difference vegetation indices. We are using the assessments to examine how green space moderates the effects of heat on physical activity in children and adults across Southern California.

1001440
Urban green spaces quality assessment and human health: using the RECITAL in Barcelona.
P. Knobel; CTFC

Abstract: The RECITAL quality assessment tool was implemented to characterize different quality aspects of the Barcelona parks. RECITAL is a multidimensional in situ quality

assessment tool for urban green spaces, primarily to characterize quality aspects relevant to human health. The tool includes 90 items divided into eleven thematic dimensions. Studies are underway to associate the quality assessments with numerous health outcomes across neighborhoods of Barcelona.

1001440
Spectral unmixing assessments of green space in Vancouver, Canada.
M. van den Bosch; Barcelona Institute of Global Health

Abstract: We used annual Landsat data (spatial resolution 30 meters) from 1984 to 2016 to identify three endmembers, high albedo (e.g., impervious surfaces), dark (e.g., shadows of tall buildings), and vegetation (grass or other types of vegetation), per each pixel in the dataset. A sub-pixel linear spectral unmixing algorithm, using the three selected endmembers, was applied to every year and an annual greenness fraction of each pixel in the study area was extracted. Values for each of the endmembers ranged from 0–100, indicating the percentage of the pixel composed of each endmember. Based on this process, the proportion of vegetation was calculated per pixel and represents the area-based green space. We are using the estimates in several studies focused on the relation between early childhood development and green space in Vancouver.

1000387
Exposure to phthalates and asthma morbidity among low-income inner-city children with asthma
L. Quiros-Alcala; Johns Hopkins University Bloomberg School of Public Health/ Deparment of Environmental Health and Engineering

Abstract: In this talk, we examine associations between repeated measures of urinary phthalate biomarkers and concurrent measures of asthma morbidity among 148 predominantly low-income, Black children (5-17 years) with established asthma in Baltimore City. Asthma symptoms, healthcare utilization, and urine samples were collected every 3 months for 12 months. Our findings suggest that exposure to phthalates may contribute to asthma morbidity in this low-income Black population.

1000387
Pesticide exposures and asthma morbidity among low-income urban children with asthma
M. Fandino Del Rio; Johns Hopkins University Bloomberg School of Public Health

Abstract: In this talk, we examine associations between repeated measures of asthma symptoms, healthcare utilization, and urinary pesticide biomarker concentrations collected every 3 months for one year among 148 predominantly low-income, Black children (5-17 years) with established asthma in Baltimore City.

1000387
The Role of Diet in Modifying the Impact of Indoor Air on Pediatric Asthma
E. Brigham; Johns Hopkins University School of Medicine

Abstract: Higher levels of indoor air pollution, including particulate matter, are known to negatively impact pediatric asthma morbidity. Dietary exposures, including omega-3 and overall dietary quality, may modify the symptomatic and inflammatory response to indoor air pollution. In this talk, Dr. Brigham will present results of a study among children with asthma, examining the interaction of these modifiable risk factors for asthma morbidity.

1000387
Characterization of Personal Fine and Ultrafine Particle Exposures among Urban Children with Asthma
K. Koehler; Johns Hopkins University Bloomberg School of Public Health

Abstract: This presentation will describe a personal exposure assessment for 50 urban asthmatic children using a backpack sampling system for PM2.5 and ultrafine exposures. Exposures will be assessed in different microenvironments and for peak exposures during sampled days.

1000387
The role of Organophosphate ester (OPE) exposures and asthma morbidity among school-aged children
L. Louis; Johns Hopkins University Bloomberg School of Public Health

Abstract: Organophosphate esters (OPE) are used as flame retardants and plasticizers in many consumer products. Emerging evidence suggests OPEs may be linked with allergic or respiratory outcomes among children. Furthermore, there are few studies of OPEs among Black children who may be at greater risk of environmental exposures and consequent adverse health outcomes. In this study, we examined associations between OPEs and asthma morbidity among 179 children (ages 5-12 years) with asthma enrolled between 2009-13.

1000387
Former and Current Smokers in High Poverty Neighborhoods Experience Heightened Impacts of Ambient Ozone
D. Belz; Johns Hopkins University School of Medicine

Abstract: In this talk, we will present findings from the SPIROMICS AIR study and demonstrate that there is a significant interaction between neighborhood poverty and ambient ozone on respiratory health. Current and former smokers living in high poverty neighborhoods experience heightened adverse impacts of long-term ambient ozone, including worse dyspnea and increased odds of COPD exacerbations.

1000387
Influence of household behaviors and indoor air pollution on adult asthma.
S. Bose; Icahn School of Medicine at Mount Sinai

Abstract: In this talk, we will present results from a longitudinal urban adult asthma cohort in Baltimore where we identified behavioral risk factors (e.g activities) associated with high indoor PM concentrations. We then showed associations between these PM exposures and asthma symptoms. In the setting of the pandemic, people are staying at home more and engaging in these activities and we thought it would be a timely message.

1000387
Rural environmental exposures and associated respiratory health outcomes
L. Palin; Dartmouth-Hitchcock Medical Center | Geisel School of Medicine

Abstract: In this talk, we will present an overview of exposures that are unique or amplified in rural environments in the US, focusing on wood fuel use, and discuss what is known about associated health risks. We will present some local data looking at citizen science based air monitoring campaigns and some early work on compositional analysis of PM collected in homes with different fuel types to explore whether wood fueled homes may have unique trace metals signatures.

RISK COMMUNICATION

1054648
Assessment of Dioxin Exposure Produced by Burning Garbage in Rural Areas of the US
E. Gonzalez-Figueroa[1], A. Bates[1], S. Hadeed[1], M. Lindsey[1], M. O'Rourke[1], L. Stone[2]; [1]University of Arizona, [2]DEP

Abstract: Burning garbage affects rural areas of the United States, resulting from the lack of sanitary disposal services. The air pollution associated with backyard burning is caused by the lack of engineering controls and the low temperature of the burn; the burn creates the environment for the release of polychlorinated dibenzodioxins and dibenzofurans (PCDD/F). This study evaluated the concentrations of dioxins released by the practice of garbage burning in rural Arizona. We sampled air pollution from garbage burned at 12 houses. First, we quantified household garbage by category (organics, plastics, metal, paper, and others) of garbage being burned. We placed air impactors between 1.52 to 3.04 meters from the burn barrel at breathing height. We sent collected samples to ALS environmental for analysis and characterization. Toxic equivalency (TEQ) for each household was estimated by following the toxic equivalent factors (TEF) from World Health Organization (WHO) and Consensus for Toxicity Factors (CTFS). Loading factors obtained through PCA show that the first two principal components explain more than 95% of the variance for both sampling seasons. The first component was influenced by houses that predominantly burned greater amounts of organic waste. Among these houses, the PCDFs were more predominant. Lastly, bootstrap linear regression models were constructed using TEQ's from WHO and CTFS as the outcome. From the five garbage categories, only organic waste was statistically significant, increasing the TEQ to TCDD 2.13 pg/kg of organic waste burned using WHO TEQ during summer and 52.53 pg/kg for winter. These local results will empower residents of communities to change their behavior regarding garbage disposal. Additional research on the release of these chemicals by garbage type is needed.

Keyword:air pollution, air toxics, hazardous air pollutant (HAP)

1054552
Preliminary estimates of fish consumption in Great Lakes Native American fish consumers: implications for risk and benefit communication

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Abstract: It is well documented that fish consumption imparts both health risks and benefits. Furthermore, fish harvest and consumption are an essential part of Great Lakes Native American (Anishinaabe) cultures. Our group recently published self-reported fish consumption estimates and risk/benefit analysis of 137 Anishinaabe participants as part of an NIEHS funded risk communication project to predict changes in behavior pre and post viewing fish consumption advice using a novel software program. Those estimates revealed that only maximum predicted intakes of fish (9,071.9g/month pre and 6,123.5g/month post) resulted in advisory exceedances for methylmercury and polychlorinated biphenyls. Mean values for that phase of the study were 1,360.78g/month pre and 1,600.4g/month post. The most recent phase of the study prospectively assessed self-reported fish consumption for 8 weeks. Anishinaabe participants (n = 238 pre, n = 207 post) recorded their fish consumption weekly with or without access to the fish consumption advice (pre/post). Controls reported consuming mean values of 464.6g/month pre and 453.0g/month post. Those with access to the advice reported mean values of 339.1g/month pre and 369.0g/month post. Given our previously published estimates from Anishinaabe fish consumers, these estimates are likely within safe fish consumption guidelines. Novel consumption advice created by and for Anishinaabe fish consumers supports safe and healthy fish consumption.

Keyword:mercury, Tribal, food

1040090
Using Risk21 to Prioritize Applications and Exposure-Driven Refinements for Plant Protection Products
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Abstract: The ILSI/HESI Risk21 framework has been shown to have many potential applications to the agrochemical safety assessment process thus enabling exposure-driven decisions to optimize and prioritize data needs. This case study was used to show how the framework could be used to clearly highlight different crop and subpopulation scenarios specific to each active ingredient in the formulated product that would require exposure mitigation measures. The examples used in this case study show that the Risk21 framework can be used to distinguish between active ingredient-specific and generalized formulated product risk mitigation measures that can be used to inform business decisions or drive specific additional data needs such as dermal absorption and dislodgeable foliar residue studies. This case study also demonstrates how the Risk21 framework can be used as an effective communication tool by providing information in a format that is easily understood by technically-diverse internal stakeholders.

Keyword:pesticides, risk assessment, other (specify below), Risk Communication

1053127
Racial Disparities in Heavy Metal Contamination of Urban Soil in the Southern US

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Abstract: Field monitoring data are sparse for addressing the disproportional burden of exposure to soil contamination in communities of minority and low socioeconomic status (SES). This study aims to examine the association between soil heavy metal levels and SES and racial composition. A total of 423 soil samples were collected in urban areas of eight cities across six Southern states in the U.S. in 2015. Samples were analyzed using inductively coupled plasma mass spectrometry (ICP-MS) for eight heavy metals. The metal data were matched with social and environmental data from the EJScreen database at the census block group level (n=423). The association was examined with mixed models with the log-transformed metal concentrations as the dependent variables and rankings of low-income or minority percentages as the explanatory variables. The full models were adjusted for environmental variables, including proximity to traffic, diesel particulate matter in air, and proximity to treatment and disposal facilities. Model results showed that soil metal concentrations were significantly associated with rankings of low-income and minority percentages. For every 10 percentiles of increase in low-income percentages, the soil concentrations of arsenic, cadmium, and lead increased by 5% (p-values <0.05). For every 10 percentiles of increase in minority percentages, the soil exposure significantly increases (p-values<0.05) for arsenic (13%), barium (4%), cadmium (6%), and lead (11%). The associations stayed significant in the full models. These findings confirmed elevated heavy metal contamination in urban soil in low-income and/or predominantly minority communities. This is the first study that documented environmental injustice in soil contamination exposure in the Southern U.S.

Keyword:environmental justice, metals, public health

1053584

Methylmercury Risk Assessment based on European Human Biomonitoring Data

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Abstract: Mercury is a global environmental pollutant which toxicity threats human and wildlife health. Among its species, methylmercury (MeHg) is the greatest cause of human health concern since it bioaccumulates and biomagnifies in the food chain. Thus, diet constitutes the most significant route of exposure for the general population. MeHg exposure in humans is influenced by the frequency of fish consumption, the species of fish and their geographical origin. The effects of MeHg include irreversible damage to the central nervous system, even at very low levels depending on the age exposure window. Consequently, MeHg poses a significant risk to fetuses and young children as it can cross the placenta and act on their developing nervous system. Women of childbearing age, pregnant women and younger children constitute a especially vulnerable population group, mainly in regions with a fish based diet. Human Biomonitoring (HBM) provides data about chemicals or metabolites in

human biological matrices, integrating all possible sources and routes of exposure and it is a powerful tool in risk assessment plans and definition of risk management measures. The aim of this study is to perform a MeHg risk assessment (RA) considering the results obtained by EFSA in 2012, and integrating data from European HBM surveys. To achieve this goal, hazard assessment based on relevant data up to 2012 (EFSA's RA) was conducted, coupled with an evaluation of the literature on dose-responses for MeHg published since 2012, and focusing mainly in neurotoxicity and neurodevelopmental disorders. Population groups for RA were then identified and HBM data in different European countries for these groups gathered. After a thorough literature review, no new dose-response information was found to modify the Tolerable Weekly Intake (TWI) value proposed for MeHg by EFSA, therefore a similar approach was selected based on TWIMeHg. In addition, an internal Risk Characterisation Ratio (RCR) was conducted using the most recent European HBM data, including the DEMOCOPHES study, and the HBM I and HBM II Guidance Values for Hg established by the German HBM Commission (Apel et al., 2017). The initial estimations based on DEMOCOPHES data have shown that the RCR, and therefore the risk of adverse health effects, varies when using the study as a whole or different countries. Further refinement of the risk assessment is needed including more HBM data to account for the differences in MeHg exposure across Europe.

Keyword:mercury, risk assessment, other (specify below), human biomonitoring, neurotoxicity

STATISTICAL METHODS IN EXPOSURE SCIENCE AND EPIDEMIOLOGY

1053641

Identification of bad actors in observed exposure mixtures when you have some causal knowledge and no idea which model to use

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Abstract: All exposures occur within the context of a larger mixture of exposures including environmental toxins, social stressors, behavioral and biologic factors, and these mixtures occur within contexts defined by historical, population specific patterns of factors like racism and sexism. A subset of these exposures is often simply referred to as an exposure mixture. The analysis of health effects of exposure mixtures often has twin goals: quantifying effects of joint exposure to all components a mixture to identify targets of broad interventions on exposure sources, and identifying "bad actors" that might serve as targets of specific interventions on individual compounds. Outside of a causal framework, searches for bad actors may result in poorly targeted interventions when epidemiologic confounding is not given appropriate consideration. Further, classical statistical issues resulting from high correlations within a mixture often result in "bad actor" searches extrapolating well beyond the data. The field of loss-based machine learning, which often focuses on optimizing predictions, offers one helpful way to quantify what a "bad actor" might be within a mixture, referred to as variable importance. Using loss-based machine learning and doubly-robust estimation within a causal framework of stochastic interventions, we demonstrate a useful

approach to variable importance that 1) optimizes, based on background knowledge, the search for bad actors within a mixture and within the broader social and historical context of the mixture and 2) quantifies bad actors in terms of measures that don't require extrapolating beyond the data and reflect importance within a given context. Machine learning allows us to avoid restrictive modeling assumptions and issues that arise when modeling within the context of highly correlated predictors with potential for non-linear and non-additive effects. We demonstrate this approach using data on Per- and poly-fluoroalkyl substances and bone mineral density from the National Health and Nutrition Examination Survey. We demonstrate some additional tools, available in a new R package, that help ensure that variable importance measures require minimal model extrapolation.

Keyword:epidemiology, artificial intelligence (AI), other (specify below), Causal inference

1053182

Variability of Urinary Concentrations of Phenols and Parabens during Pregnancy in First Morning Voids and Pooled Samples

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Abstract: Background/Objective: Urinary concentrations of phenols and parabens have been extensively used as biomarkers of phenol and paraben exposure during pregnancy. However, because phenols and parabens are quickly metabolized and eliminated in urine, characterizing their long-term average exposure is challenging from a few spot samples. Methods: We quantified five phenols and four parabens in 357 first morning voids (FMVs) and 203 pooled samples collected during the 2nd and 3rd trimesters of 173 pregnancies in the MARBLES (Markers of Autism Risk in Babies – Learning Early Signs) study. We computed intraclass correlation coefficients (ICCs) by sample type (FMV or pool) across two trimesters and by the number of composite samples in the pools, ranging from 2 to 4, within the same trimester. Results: Among nine target compounds, bisphenol A (BPA), methyl paraben (MEPB) and propyl paraben (PRPB) were detected in more than 50% of the samples. Regardless of sample type, ICCs were low for BPA (0.17-0.29) for which diet is a primary exposure source, indicating low reproducibility, while those were relatively high for MEPB (0.51-0.68) and PRPB (0.52-0.65) for which personal care products are a primary exposure source, indicating high reproducibility. ICCs across two trimesters were higher in pools (0.29-0.68) than FMVs (0.17-0.52) and the highest ICC within the same trimester was observed when pooling either two or three composites. Conclusions: Our findings support that pooling multiple biospecimens within the same subject can increase reproducibility of pregnant women's phenol and paraben exposure and thus could potentially minimize exposure misclassification and reduce analytical cost.

Keyword:biomarkers, consumer and personal care products, statistical methods

1053040

Collection, Curation, and Quantitative Structure-Use Relationship Modeling of Flame Retardants and Organohalogenated Flame Retardants for Class-Based Assessments

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Abstract: To date, many attempts have been to compile comprehensive lists of flame retardants. However, this has proven challenging, due to the heterogeneity of compounds that can be used as flame retardants, coupled with changes in formulation chemistry over time. For example, legacy flame retardants may no longer appear on lists of flame retardants currently in use; but durable goods that contain these compounds may still reside in home and work environments for many people, leading to potential continued exposure. In addition, new chemicals that can be used as flame retardants are continually introduced into commerce. Here, efforts are described to carefully curate a list of all flame retardants and organohalogen flame retardants (OFR) from open data sources of academic literature and international regulatory agencies. Although this list of flame retardants is intended to be universal, the authors acknowledge it will not be exhaustive. For example, reporting rules in the United States and other countries allow manufacturers to classify such information as confidential business information. Thus, the name of a compound and/or that its intended function in products as a flame retardant may not be public knowledge. For this reason, compounds from this universe of flame retardants were used to construct refined quantitative structure-use relationship (QSUR) models, which take a chemical structure as input, and return the probability that a chemical will have a given functional use. A two-level hierarchical consensus classification model is constructed, which first predicts if a compound is a flame retardant, and second, if it is an OFR. Using this refined QSUR, a case study is presented that assesses the ability of QSUR models to predict functional use as FRs and OFRs for the entire curated list and an independent evaluation data set. The purpose of the FR and OFR lists, coupled with refined QSUR models, is to assist regulatory bodies and other organizations that require characterization of chemical uses to scope their chemical hazard, exposure, or risk assessments. Disclaimer: The views expressed in this abstract are those of the author(s) and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency or Consumer Product Safety Commission.

Keyword:artificial intelligence (AI), flame retardants, risk assessment

1052788

Update of Open Source Population Variability Simulator for Toxicokinetic Modeling

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Abstract: Toxicokinetics (TK) data needed for chemical risk assessment are not available for most chemicals. In order to support a greater number of chemicals, the freely available R package “httk” (High Throughput Toxicokinetics) includes functions and data tables for simulation and statistical analysis of chemical TK. The HTTK-pop Monte Carlo (MC)

simulator, one of the functions in HTTK package, simulates toxicokinetic variability by using biometrics from the U.S. Centers for Disease Control and Prevention National Health and Nutrition Examination Survey (NHANES). The NHANES provides both biometric and chemical exposure biomonitoring data that are statistically representative of the modern U.S. population. However, the current version of HTTK package utilizes data only up to the 2011-12 NHANES cohort. To update the HTTK-pop MC, the most recent NHANES biometrics (up to the 2017-18 NHANES cohort) were obtained. A comparison of the previous cohort (2007-12 NHANES cohort) and updated cohort (2013-18 NHANES cohort) indicates some increase in mean and median body weights for the updated cohort with no change or a slight decrease in body heights. In addition to biometrics, we examined alternate model structures in the HTTK package to model excretion by the kidney. Equations describing glomerular filtration rate (GFR) were revised to more accurately represent physiology and population racial (as a social construct) variability. The model outputs (the steady-state plasma concentrations) from the updated GFR model structure were compared with the previous model. The revised NHANES biometric data within HTTK-pop, GFR population prediction and variability, and the GFR physiological modeling structure produced refined estimates. In addition, a revised workflow to integrate new NHANES cohort data as they are published was developed, which also provides a template for analysis of other similar cohort biometric datasets. The views expressed here are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

Keyword:statistical methods, PBPK Modeling, exposure models

1052692

Meta-Analysis Results from Children's Soil and Dust Ingestion Rate Studies

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Abstract: Ingestion of soil and dust by children is a potential source of exposure to environmental contaminants. However, robust data for this exposure factor are lacking for many of the children's age groups of interest to EPA. We conducted a literature search to identify available soil and dust ingestion rates for children based on published results from three main types of studies: trace element-based mass-balance (MB) studies, biokinetic studies, and activity pattern studies. Our goal was to pool the results from all three categories of studies using alternative meta-analysis approaches. Our focus was to derive pooled estimates of total soil plus dust ingestion rates, along with their confidence intervals for various age groups of children of interest to EPA, within the age range from 0 to 21 years old. First, we evaluated the reliability of tracers used in different MB studies and the physical interpretation of reported results. We concluded that the published "soil" ingestion rates did not always represent "soil" or "soil plus dust" ingestion rates, depending on the tracers used. We then developed a novel approach to physically estimate soil plus dust ingestion rates by adjusting the data from published (Best Tracer Method) MB studies. These modified results were then pooled with estimates of soil plus dust ingestion rates derived from biokinetic and activity pattern studies as part of the meta-analysis. Results from the meta-analysis were produced for each age group and study type, as well as for all three study types combined.

Several different statistical methods were used to calculate the estimates and their confidence intervals for the mean total soil plus dust ingestion rates. Specifically, we used a fixed effects method (inverse variance method), two different random effects methods, and the maximum likelihood method. This analysis produced estimates of soil and dust ingestion rates in finer age ranges than presented in current guidance. We compared several of our results with existing recommendations for various age groups from EPA's Exposure Factors Handbook. This presentation will share details on the approach and results generated.

Keyword:soil, exposure factors, statistical methods

1052851

Source-to-Dose in the Combined Human Exposure Model

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Abstract: The Source-to-Dose module in the CHEM suite calculates estimated exposures over the course of a year for the sample population. This is done by taking in a simulated population, such as the one created with RPGen, and a product use diary, such as the one created with Product Use Scheduler, and determining how much exposure can be expected from each product that is used, essentially taking the list of sources and converting it into a longitudinal assessment of estimated exposure for each individual. These longitudinal calculations can account for both compounding effects, such as reapplication before the effects of the previous use have dissipated, and lasting effects, such as an aerosol that lingers in the air for weeks, resulting in continuously smaller, though still non-zero, exposures for the entire period. Recent additions to Source-to-Dose include calculations for exposure due to diet and articles. We intend to further develop the dietary section to more accurately model effects of water contamination on a population, specifically with the 1,4-Dioxane case study in mind. Disclaimer This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication

Keyword:aggregate exposure, statistical methods, consumer and personal care products

1054089

Exploring applications and challenges of agent-based models in exposure science

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Abstract: It is well-documented that an individual's exposure to harmful chemicals varies spatially and temporally. For example, exposure might occur primary at home, at work, or in the built and/or natural environment, and may be greatest during the day or at night. Exposure may also be tied to specific behaviors in these environments, such as food or water intake, or use of consumer products. However, movement and behavior patterns can differ dramatically between individuals based on demographic and social factors, which mediates the susceptibility of various subpopulations. Thus, exposure estimates can be improved by accurately modeling an individual's behavior, movement through the environment and interaction with other individuals based on these factors. Agent-based models (ABMs) or

individual-based models, which simulate the behaviors and interactions or autonomous agents within a system, offer a method to model these factors at scale of individuals, allowing us to explore how behavior, demographic information, and social factors shape exposure to harmful chemicals. ABMs also exhibit emergent properties due to interactions between agents, adding insight into how exposure at the individual level scales up to risk for the population. However, the data needed to parameterize such models (e.g., activity logs) are challenging to acquire and often cover short time scales. Additionally, model calibration and inference are statistically challenging because ABMs do not have defined likelihood functions. In this presentation we will explore applications of ABMs within the U.S. Environmental Protection Agency and the field of exposure science more generally and review potential data sources. We will also introduce Approximate Bayesian Computation as a likelihood-free approach for model calibration and inference.

Keyword:behavior, exposure models, other (specify below), agent-based models

1054108

Predicting Chemical Occurrence in Environmental and Biological Media

L. Eddy, K. Isaacs, C. Ring, K. Phillips, J. Sobus, E. UIrich; Environmental Protection Agency

Abstract: Monitoring of chemical occurrence in various media is critical for understanding the mechanisms by which human and ecological receptors are exposed to exogenous chemicals. Since monitoring studies are expensive, data have not been exhaustively collected for the tens-of-thousands of chemicals in commerce. To fill this gap, predictive models can be used to anticipate chemical presence and inform prioritization for further study. Here we present a suite of random forest models which integrate data from dozens of public monitoring sources to predict chemical occurrence in 25 different environmental and biological media. For each medium, classifier models were built to predict the probability of any given chemical being detected in that medium. Regression models were further developed to predict quantitative global detection rates for novel compounds based on their similarity to chemicals previously characterized in the media of interest. These models utilize descriptors for physicochemical properties, structural characteristics, and uses. All models were evaluated using out-of-bag error, 5-fold cross-validation, and y-randomization. Classification models having an average out-of-bag error rate of <15% could be built for 22 media. We compared the performance of two distinct regression modeling approaches – one which places more emphasis on training set chemicals having more information, and another which weights the information for all chemicals equally. Preliminary results suggest better performance from the regression model that weights all chemicals equally. In the equal-weights model, the out-of-bag error is <10% for 20 out of 25 media. In the model which places higher weight on data-rich chemicals, the out-of-bag error is <10% for only 4 out of 25 media. The regression models can be used in tandem with the classification models to provide more holistic predictions of occurrence for chemicals having no monitoring data. Final versions of our models will be tested on external data sets to assess their ability to predict emerging environmental exposures. These models have the potential to inform the development of 1) workflows for environmental decision-making, and 2) methods for assessing unknown structures in non-targeted analyses of environmental and biological

media. The views expressed here are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

Keyword:multimedia, statistical methods, exposure models

1054124
Evaluation and Refinement of Quantitative Structure-Use Relationship (QSUR) Models for Chemical Function
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Abstract: The U.S. Environmental Protection Agency's (EPA's) Office of Research and Development previously developed high-throughput quantitative structure-use relationship (QSUR) models that use the structure of chemicals to predict their functional use in consumer products and processes. These models can be used to fill gaps in exposure-relevant information for poorly characterized chemicals. Here, we evaluate these models based on industry-reported chemical functional uses from EPA and Health Canada and refine the models to improve performance and incorporate new harmonized functional use categories. The evaluation showed that the models were successful at predicting industry-reported chemical functional uses when the chemicals in question were within the models' applicability domain (AD). However, many chemicals with reported industrial uses were outside the ADs of the QSUR models, as they were trained with data from primarily consumer product sources. To expand the model domain and refine model application, new data from the industrial sector were incorporated into an updated modeling framework that includes sector of use. The functional use dataset was augmented to include industry-specific functions from EPA's Chemical Data Reporting (CDR), and the data were re-mapped to 107 internationally harmonized functional use categories developed by the Organisation for Economic Co-Operation and Development (OECD). New consensus QSURs were built for the OECD harmonized categories using a standardized workflow that included model validation. To address sector of use, a machine learning classifier model was built to predict consumer and/or industrial use. This model was applied to the augmented functional use data to assess the relevance of the model training data to each sector, with 75.7% of chemicals predicted to have industrial use, 60.4% having consumer use, and 55.5% having both. In the future, this model can be used to stratify QSUR training sets by sector. These refined QSUR models will inform existing models for predicting chemical release, consumer product composition, and exposure from chemical properties and structure, ultimately improving chemical prioritization workflows. 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.

Keyword:statistical methods, chemical prioritization, exposure models

1054256
Using quantile regression to identify the determinants of pesticide concentration in house dust when there are large proportions of non-detects

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Abstract: Background: Environmental data, such as pesticide concentrations in house dust, often include large proportions of measurements below the limit of detection. Quantile regression does not require assumptions about the exposure distribution of non-detects. Additionally, one can specify the quantiles to be estimated. Objective: To use quantile regression to identify the determinants of pesticide concentrations in house dust. Methods: We collected 138 house dust samples from participants in the Biomarkers of Exposure and Effect in Agriculture Study, which we analyzed for >30 pesticides. We evaluated three metrics of occupational use in the past 12 months: yes/no, number of days of use, and intensity-weighted days. Intensity-weighted days was estimated by multiplying days of use by an algorithm-derived intensity-weighting factor that accounted for use of personal protective equipment and other factors that influence exposure intensity (application method; whether the applicator mixed pesticides). We also evaluated home/garden use, home characteristics, and hygiene factors (e.g., shoe removal). We used quantile regression to examine whether these factors predicted the 75th and 50th percentiles of the dust concentration. We report malathion here and will expand these analyses to other pesticides. Results: Malathion was detected in 68% of the samples. The predicted 75th percentile was 12 ng/g for no malathion use (80% of participants) and 861 ng/g for home/garden use [9% of participants; 95% Confidence Interval (CI): 689-1033]. Intensity-weighted days had the strongest association of the three occupational metrics: the predicted 75th percentile increased 27 ng/g (95%CI: 6-48) for every 100 units (median=165, max=2400). A non-significantly elevated concentration was observed in those who lived <100 yds from treated fields if they also reported occupational use compared to those with no occupational use and any distance from field. We found no association with building age, carpet age, shoe removal, and vacuum type. We found similar predictors for the 50th percentile, except that the strongest association with occupational use occurred for days of use (+71 ng/g (95%CI: 30-112) for every 10 days). Conclusion: Quantile regression is a promising method to understand pesticide exposure, particularly when there are many non-detects. Occupational and residential use of malathion in the last 12 months were significant determinants of malathion house dust concentrations.

Keyword:pesticides, exposure factors, regression

1054223

An expectation-maximization approach for accommodating non-detect data in geospatial Gaussian process models

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Abstract:A common approach for predicting external environmental exposures is linear regression with spatially references covariates, known as land-use regression (LUR). Generalizations of LUR include Kriging or Gaussian process regression, which incorporate explicit terms for spatially correlated errors. In recent work, we developed a scalable approach for simultaneous variable selection and estimation of land-use regression parameters by combining scalable Gaussian processes with a penalty on the LUR parameters. Here, we extend the Gaussian process regression with penalized model selection to accommodate left-censored, or non-detect, observations using an expectation-maximization

(EM) approach. Censored data in the EM step are calculated as the expected value of the truncated Normal distribution estimated from the observed data and the Gaussian process prediction at the current iteration. We conduct a series of simulations representing a wide range of realistic geospatial chemical distributions. Preliminary results indicate that the EM approach allows for consistent estimation of LUR parameters and out-of-sample prediction accuracy up to fifty percent censoring of the data. The approach provides a flexible method for geospatial exposure prediction of datasets with left-censored observations while avoiding common pitfalls or statistically questionable assumptions.

Keyword:statistical methods, geospatial analysis/GIS, exposure models

1048195

Development of land-use regression models for ambient air pollutants in northern Taiwan

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Abstract: To provide long-term air pollutant exposure estimates for epidemiological studies, it is essential to test the feasibility of developing land-use regression (LUR) models using only routine air quality measurement data and to evaluate the transferability of LUR models between nearby cities. In this study, we developed and evaluated the intercity transferability of annual-average LUR models for ambient respirable suspended particulates (PM10), fine suspended particulates (PM2.5), nitrogen dioxide (NO2) and ozone (O3) in the Taipei–Keelung metropolitan area of northern Taiwan in 2019. Ambient PM10, PM2.5, NO2 and O3 measurements at 30 fixed-site stations were used as the dependent variables, and a total of 156 potential predictor variables in six categories (i.e., population density, road network, land-use type, normalized difference vegetation index, meteorology and elevation) were extracted using buffer spatial analysis. The LUR models were developed using the supervised forward linear regression approach. The LUR models for ambient PM10, PM2.5, NO2 and O3 achieved relatively high prediction performance, with R2 values of > 0.72 and leave-one-out cross-validation (LOOCV) R2 values of > 0.53. The intercity transferability of LUR models varied among the air pollutants, with transfer-predictive R2 values of > 0.62 for NO2 and < 0.56 for the other three pollutants. The LUR-model-based 500 m × 500 m spatial-distribution maps of these air pollutants illustrated pollution hot spots and the heterogeneity of population exposure, which provide valuable information for policymakers in designing effective air pollution control strategies. The LUR-model-based air pollution exposure estimates captured the spatial variability in exposure for participants in a cohort study. This study highlights that LUR models can be reasonably established upon a routine monitoring network, but there exist uncertainties when transferring LUR models between nearby cities. To the best of our knowledge, this study is the first to evaluate the intercity transferability of LUR models in Asia.

Keyword:air pollutants, exposure models, statistical methods

1048314

A recommended practice for determining the intraclass correlation coefficient of a urinary biomarker: in case of organophosphate metabolites in pre-school children

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Abstract: Exposure to chemical is often assessed using a biomarker. It is important to select a reliable biomarker to prevent misclassification and bias. An intraclass correlation coefficient (ICC) is commonly used for evaluating the test reliability. However, the method of calculating the ICC in an experimental setting is not standardised. We evaluated several ways to calculate the ICC of biomarkers, using urinary dialkylphosphate (DAP) concentrations, biomarkers of organophosphate pesticide (OPP) exposure, and formulated a standardised practice. Urine samples were collected from 51 children aged from 4 to 6 years twice per day (a first morning void sample and a spot sample after lunch time) for four consecutive days in a kindergarten located in Japan from 2014 to 2015. Specific gravity (SG)- or creatinine-normalised urinary DAP concentrations including dimethylphosphate (DMP), diethylphosphate (DEP), dimethylthiophosphate (DMTP), diethylthiophosphate (DETP), dimethyldithiophosphate (DMDTP) and diethyldithiophosphate (DEDTP) analysed with an LC-MS/MS were used for calculating the ICCs with the ICC(A, 1) model. The concentrations below the method reporting level (MRL) were imputed; for comparison, the concentrations were also substituted by the MRL/√2. The ICCs for DMDTP, DETP and DEDTP were not determined due to low detection rates (< 50%). The median SG-normalised urinary concentrations (interquartile ranges) of DMP, DMTP and DEP were 6.25 (3.24–11.6), 8.29 (3.56–23.3) and 5.67 (2.98–10.3) ng/ml, respectively. The reliability of SG-normalised concentrations of spot urine samples (the ICCs of DMP, DMTP and DEP were 0.39, 0.28 and 0.54, respectively) was as high as that of first morning void samples (0.50, 0.31 and 0.52, respectively). The recommended method for the ICC calculation is to impute values below the MRL only when the detection rate of a chemical is more than 50% of the samples, to normalise urinary concentrations with SG and to calculate the ICCs using the ICC(A, 1) model. The urinary DAP concentrations in spot urine samples as well as first morning void samples can be used for future epidemiological studies of children to evaluate the risk of OPP exposure.

Keyword:pesticides, biomarkers, other (specify below), intraclass correlation coefficients

1049483

Modelling body mass distribution in the French population for exposure assessment purposes: a probabilistic approach

J. Botton[1], Y. Oulhote[2], S. fraize-frontier[3], J. Botton[4], Y. Oulhote[5], C. Thorin[6], F. Clerc[7], A. Ficheux[8], R. Bonnard[9], A. Thomassin[10], S. Hulo[11], N. von Goetz[12], B. Guinhouya[13], I. Guseva Canu[14], C. Roth[15], S. FRAIZE-FRONTIER[15]; [1]EPI-PHARE, [2]University of Massachusetts, [3]Anses, [4]EPI-PHARE, Epidemiology of health product, [5]University of Massachusetts at Amherst & Harvard T. H. Chan School of Public Health, [6]Oniris, [7]French National Research and Safety Institute (INRS), [8]Université de Brest, [9]Institut National de l'Environnement Industriel et des Risques (Ineris), [10]Institut de Radioprotection et de Sûreté Nucléaire (IRSN), [11]ULR 4483 - IMPECS - IMPact de l'Environnement Chimique sur la

Santé humaine, CHU Lille, Institut Pasteur Lille, Univ. Lille, [12]Swiss Federal Office of Public Health (FOPH), [13]ULR 2694- METRICS, Univ. Lille, [14]Center for Primary Care and Public Health (Unisanté), [15]French Agency for Food, Environmental and Occupational Health & Safety (ANSES)

Abstract: Background and Aim: Body mass is a crucial parameter to assess the risks associated to chemical exposures in various populations (e.g. children, women of childbearing age). Distribution of body mass is highly dependent on location, age, sex, and socioeconomic status. We aim to model the distribution of body mass in the French population over all ages, taking into account sex, region, socioeconomic status and time trends to propose probabilistic values of body mass distribution in specific sub-populations for use in risk assessments. Method: A systematic review was conducted to identify and select studies with individual data of body mass measured on representative samples of the French population (general population or sub-populations) for which measurement's date, and the individuals' age, region of residence, profession and gender are available. We used Generalized Additive Models for Location, Scale and Shape (GAMLSS) with Box-Cox Power Exponential distribution to model body mass distribution according to age, sex, year of measurement, region and profession. We present specific probabilistic distributions of body mass across these factors. An uncertainty analysis was conducted to identify the sources of uncertainty and evaluate their impacts on the results. Results: Individual data from 10 studies, corresponding to over 1 million individuals were retrieved. Age and sex were the main contributors to the body mass distribution. In adults of 30y, the median and interquartile range were 76.7 [68.2 – 87.9] for men and 61.1 [53.9 – 70.7] for women, respectively. More specifically, the same body mass distribution parameters in a population of women from 15 to 49 years altogether was 65.7 [57.7 – 75.9]. Conclusion: GAMLSS modeling enabled us to draw the distribution of body mass in the French population over all ages. Including important characteristics associated with body mass distribution enabled to predict the most realistic distributions for any specific subpopulation.

Keyword:exposure factors, statistical methods, other (specify below), Body mass

1049888

Advances in Bayesian kernel machine regression for estimating the health effects of complex environmental mixtures

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Abstract: Bayesian kernel machine regression (BKMR) is increasingly being adopted as a tool for estimating the health effects of environmental mixtures. This approach simultaneously estimates the multi-dimensional exposure-response function and incorporates variable selection to identify important mixture components. An R package is available which flexibly implements the methods and provides features for summarizing the multivariate

exposure-response surface, including overall, single-exposure, and interactive effects. In this talk, we provide an overview of BKMR, highlight applications that illustrate how the methodology can address different scientific questions of interest, and describe recent advances that generalize the approach to the time-varying exposure and mediation analysis settings.

Keyword:statistical methods, Bayesian, multiple stressors

1050298

Using Self-Organizing Maps to Identify Metal Mixture Exposures among Pregnant Women in Rural Northern Bangladesh

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Abstract:INTRODUCTION: The high dimensionality of mixtures data can make epidemiologic studies challenging. A self-organizing map is a machine learning technique that reduces multi-dimensional data into two-dimensional space while preserving topological relationships in the data. A data set with p exposures measured in n participants is expressed as clusters of participants with similar exposures. The defining feature of the algorithm is that clusters are organized on a two-dimensional “map” (of p-dimensional space, not geographic space) such that proximal clusters have more similar exposures than distal clusters. OBJECTIVE: To use self-organizing maps to identify clusters of pregnant women in rural northern Bangladesh with similar metal mixture exposures. METHODS: Spot urine samples were collected from pregnant women (n=783) at enrollment in the Pregnancy, Arsenic, and Immune Response Study. Urinary Cd, Mn, Mo, and W were measured by ICPMS. Urinary As was speciated by HPLC-ICPMS, and the sum of inorganic, monomethyl, and dimethyl As was used. The LODs were 0.002-0.76 µg/L. For concentrations < LOD (Mn [7.7%], W [3.4%]), we imputed LOD/sqrt(2). Concentrations were specific gravity-corrected, natural log-transformed, and z-scored. We implemented self-organizing maps using the R package ECM. The number of clusters was determined by comparing diagnostic criteria for 2-50 clusters, balancing parsimony with Akaike’s Information Criterion (AIC) and proportion of total variance explained (R2). RESULTS: Geometric means in the full sample were 33.8, 0.32, 0.36, 72.3, and 0.3 µg/L for As, Cd, Mn, Mo, and W, respectively. A 4x4 map with 16 clusters explained > 70% of total variance (R2=0.71) in our data. Visualization indicated that urinary Mo and W, and to a lesser extent As, tended to co-occur. Urinary Mn and Cd varied inconsistently with other metals. Two clusters (n=13, 21) had mean z-scores > 3 for Mn. Of these, one had mean z-scores near 1 and the other had mean z-scores near -1 for As, Cd, Mo, and W. DISCUSSION: A self-organizing map described metal mixture exposures among pregnant women in rural northern Bangladesh. There may be a common source of As, Mo, and W and a source of high Mn that varies inconsistently with the other metals. Future research could compare clusters to identify sources of exposure (e.g., foods). Additionally,

map coordinates could be used as a continuous measure of metal mixture exposures in studies investigating sources and health outcomes.

Keyword:metals, multiple stressors, prenatal

1050373

Connecting research methods to scientific assessments and informing policy

K. Rappazzo; United States Environmental Protection Agency (US EPA), Office of Research and Development, Center for Public Health & Environmental Assessment

Abstract: Methods that employ machine learning and estimating algorithms are growing in popularity in environmental research. These methods are often complex, and the results can be difficult to interpret, specifically when the methods aim to disentangle the effects of complex environmental mixtures. When interpretations are not straightforward or clearly interpreted, it is difficult for policy- or decision-makers to consider the evidence from studies of complex mixtures. As such, the ways in which policies and regulations are developed may exclude the results of this research from consideration in scientific assessments. In order to ensure that research using these techniques are incorporated into public health assessments and used to inform policy development, it is necessary to consider how assessments are performed and how the results of this research may be presented most effectively. This presentation will provide a brief overview of how mixtures and machine learning methods are currently treated and suggest potential steps that could help future research in being used to inform environmental health policy. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the US EPA.

Keyword:public health, exposure models, policy

1051664

Preparation of a data set of exposure factors at personal level with missing-data imputation -A case study in Japan-

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Abstract: There are various consumer products around us, which are one of the sources of exposure to chemical substances. It is necessary to understand the amount of exposure in order to investigate the health effects and the existence and magnitude of health risks due to exposure to chemical substances from products. In many cases, exposure assessment has been performed by an estimation method rather than direct measurement. In addition to setting exposure scenarios, data on exposure factors are required for exposure estimation. Yokohama National University (YNU) has cooperated with the National Institute of Technology and Evaluation (NITE) to estimate the amount of chemical substance exposure from consumer products using the results of a questionnaire survey on living behavior conducted by NITE. However, many missing values have been found in the response data, and few respondents have all the exposure factors. Estimates using only non-missing values may not accurately reflect the exposure status of all subjects. Considering the above points, we are currently

studying the development of an exposure factor database for Japanese customers by imputing missing values. Furthermore, using this database, we are also estimating chemical exposure from consumer products considering the relationships between the factors. In this symposium, we will report on the results and the challenge of our preliminary study.

Keyword:consumer and personal care products, exposure factors, risk assessment, missing data imputation

1054571

Modelling the inhalation rate in the French population for exposure assessment purposes: a probabilistic approach

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Abstract: Background and Aim: Inhalation rates (IR) is an essential factor when assessing inhalation exposure to chemical, physical or biological agents. An individual's IR depends on age, sex, weight status (WS) and the intensity and the duration of activities performed. We aimed to model distributions of daily inhalation rate (DIR) and IR per physical activity level for the French population taking into account age, sex, and WS. Method: An energy-based approach using Layton's equation was used to estimate the DIR. DIR (m3/day) of an individual was calculated as: DIR = E×H×VQ×10-3, where H is the oxygen uptake factor (L/kcal)(Children: 0.202 vs Adults: 0.201), VQ, the ventilatory equivalent for oxygen (sedentary to low-intensity activities: 25 vs higher-intensity activities: 27) and E, the total daily energy expenditure (kcal/day). E was established on the basal metabolic rate (BMR) and the energy cost of different daily physical activities of an individual, expressed as metabolic equivalent tasks (METs). The BMR was assessed using predictive equations from the literature as a function of age, sex, body mass, height and WS. The METs associated to activities were determined using the Ainsworth, Ridley and Butte compendia. Through probabilistic simulations of METs, a robust distribution of IR was obtained. An uncertainty analysis was performed to identify the sources of uncertainty and evaluate their impacts on the results. Results: We selected the French Time Use Survey (2009-2010)(FTUS) as a key study. FTUS was conducted on almost 18 000 participants from 11 years who provided 27 903 daily diaries with all activities performed with a 10-minute time step. Distribution of BMR, DIR and IR per physical activity level (sedentary, light, moderate, vigorous) were derived by age-group, sex, and WS, thus yielding mean, standard deviation, 1%, to 99%

percentiles and their 95% confidence interval (CI). For example, in 30-65 year olds in France, the median DIR expressed in m3/day as estimate [lower-upper limits 95% CI] for men are 17.18 [17.12-17.25] if normal weight, 17.84 [17.77-17.90] if overweight, 19.51 [19.39 – 19.64] if obese. For women, the equivalent PDIR are 14.05 [14.01 – 14.09] if normal weight, 14.14 [14.05-14.22] if overweight, 14.80 [14.71-14.9] if obese. Conclusion: The established distributions will allow a more precise estimation of IR reference values for air quality standards and will contribute to ensure a safe environment in daily life or at work.

Keyword:exposure factors, statistical methods, other (specify below), Inhalation rate

1054467

Characterizing Exposure Trends from NHANES Urinary Biomonitoring Data

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Abstract: Biomonitoring studies provide valuable data on the chemicals present in the human body at the time of measurement. However, to prioritize chemicals in the environment for further study, we need to know which chemicals, and their levels of exposure, are contributing to the observed biomonitoring metabolite concentrations. We employed a recently developed approach using Bayesian methodology to infer ranges of exposure to parent compounds consistent with urinary biomarker levels reported in the U.S. Centers for Disease Control and Prevention's National Health and Nutrition and Examination Survey (NHANES), which is representative of the U.S. population. The publicly available R package named bayesmarker, was applied to all NHANES 2-year cohorts. To obtain exposure estimates for environmental chemicals, metabolites were linked to likely parent chemicals using information from the NHANES reports and text mining of PubMed abstracts. The 151 NHANES metabolites (spanning from 1999 to 2016) were linked to 179 unique parent chemicals by 270 associations, with up to 18 different potential parent chemicals for a single metabolite. By examining all NHANES cohorts, we can obtain a clearer understanding of chemical exposure over the past two decades and prioritize chemicals for further study. Using the bayesmarker package, chemical exposure values were inferred for each NHANES cohort individually and temporal exposure trends were identified. The chemicals di-isononyl phthalate, ethylbenzene, and deltamethrin exhibited the greatest increase in exposure over time. Trends were stratified by chemical class as well as clustered to identify common patterns of exposure over time. Temporal forecasting was used to categorize chemicals by anticipated changes in exposure: likely to increase, decrease, or stay the same in the upcoming NHANES cohorts. We also prioritized chemicals for each demographic group by identifying those with the highest divergence in exposure from the average of the total population over time. Lastly, we further demonstrated the versatility of the bayesmarker package by combining NHANES datasets by decade (2000s and 2010s) for increased statistical power to identify more robust exposure changes. The tools and methods used to create these analyses have been thoroughly documented in preparation for peer-review and public distribution to the biomonitoring community. This abstract does not necessarily reflect U.S. EPA policy.

Keyword:Bayesian, biomonitoring, exposure models

1054614

Estimation of the time use in activities and locations in the French population for exposure assessment purposes: a probabilistic approach

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Abstract: Background and Aim: Lifestyle, especially time spent practicing different activities (e.g. sport, household cleaning, travelling) and places (e.g. indoor or outdoor) are critical determinants of an individual's exposure to a harmful agent (chemical, physical, organizational). The individual's activities, their frequency, duration and location, all depend on region, sex, age and socioeconomic status. We aim to review the activities of the French population and to assess, for each activity, the fraction of participating population (FP) and the distribution of time spent by the FP practicing the activity, according to age, sex, and region. Method: The French Time Use Survey (2009-2010) (FTUS) conducted on a representative sample of about 18,000 participants form 11 years, was selected as key study. Each participant reported all activities performed, their nature and location, using a daily diary with a 10-minute time step for one or two days (27,903 diaries). The survey design was accounted for when calculating statistics to provide the representative results of the French population (i.e., FP and Daily duration (DD) mean, standard error, min, max and percentiles (1, 2.5, 5, 10, 25, 50, 75, 90, 97.5, 99), along with their 95%-confidence intervals). Results: Almost 100 activities and locations were reviewed. The FP and DD of activity vary according to sex, age and region. For instance, it is clear that children (C) practice the most and spend the more time on sports compared to adults (A) and elderly (E) (FP = (C: 0.23; A: 0.09; E: 0.07); DDmean = (C: 141 min; A: 106 min; E: 87 min)). Likewise, women (W) appear clearly more involved in household cleaning than men (M) (FP = (W: 0.62; M: 0.25); DDmean = (W: 74 min; M: 57 min)) and the elderly, more than adults and children (FP = (C: 0.18; A: 0.44; E: 0.55); DDmean = (C: 47 min; A: 69 min; E: 74 min)). In contrast, for time spent in transport, the difference between sexes is not as clear-cut, even though DD are greater for men than for women, the opposite is observed for FP (FP = (W: 0.64; M: 0.60); DDmean = (W: 82 min; M: 85 min)). Similarly, no age group stands out in terms of both FP and DD (FP = (C: 0.57; A: 0.64; E: 0.59); DDmean = (C: 79 min; A: 84 min; E: 81 min)).

Conclusion: These data are essential for the most realistic health risk assessment and decision taking regarding occupational and environmental exposures, which depend on the duration and frequency of the activities generating this exposure.

Keyword:activity patterns, exposure factors, statistical methods

1054636

Inequitable distribution of environmental cancer risk by racial and socio-demographic factors throughout the US rural-urban continuum.

P. Hurbain[1], D. Li[2], Y. Liu[2], M. Strickland[1]; [1]University of Nevada Reno, [2]University of Nevada, Reno

Abstract: Systemic racism effects have longstanding negative health outcomes. The goal of this study was to analyze population-level metrics of race and socio-demographic and their influence on a region's estimated air pollution based cancer risk for the entire U.S., accounting for the joint effects of the rural-urban continuum. Census tract-level estimated cancer risks from air toxics were retrieved from the National Air Toxics Assessment. Sociodemographic data obtained from the U.S. Census Bureau included race, income, and education estimates for each tract for years 2011 and 2014. Spearman correlation coefficients were generated to describe the relationship between sociodemographic factors and cancer risk. Linear regression models were used to examine how the relationships between sociodemographic factors and cancer risk varied by urbanization. Results of correlation analysis shows a consistent positive correlation with cancer risk and increasing proportions of minority households. The correlation with increasing levels of income was negatively correlated with cancer risk, as was increasing proportions of high school completion. The effect of the rural-urban continuum was also correlated with cancer risk, where living in more urban, metropolitan areas was positively correlated with cancer risk. Results of multivariate linear regression analysis show as areas become increasingly less white, the cancer risk increases even as the income and education attainment of that census tract increases. Areas with the highest cancer risks, tend to be distributed among lower income, minority households, around large metro areas with lower high school education attainment. The joint effect analyses demonstrated that race and rural urban status of a census tract are highly significant in estimated cancer risk, only for increases of black, Hispanic and other households around metro areas. To our knowledge, this is the first study of environmental justice in NATA cancer risks on the census tracts level for the entire U.S. Results of this work indicate a consistent effect of higher exposure to carcinogenic air pollutants on average among increasing proportions of minority households at the census tract level across the U.S. Future works could focus additional attention to substrata within census tracts, and integrate more accurately represented effects of localized pollution from transit vehicles and small business exhaust plumes alongside ambient effects from industry.

Keyword:air pollution, public health, environmental justice

1055077

Beneficial impacts of a reduced drift pesticide formulation on potential applicator inhalation exposure and risk

C. Fleming, P. Havens; Corteva Agriscience

Abstract: Inhalation and dermal exposures may occur when mixing, loading, and applying pesticides in an agricultural setting. Enlist™ herbicides are formulated with Colex-D® technology to reduce driftable fines — those prone to move away from the target during application — without increases in overall droplet size. Because of the similarity in size between driftable fines (aerosols ≤ 150 um) and inhalable spray (aerosols ≤ 100 um), it is anticipated that inhalation exposures in applicators applying Enlist formulations would also be reduced compared to applications of formulations without Colex-D® technology. Measured droplet size distributions for Enlist Duo® (a formulation containing 2,4-D choline and glyphosate with Colex-D® technology) and a tank mix of glyphosate and 2,4-D-dimethyl amine (without drift reduction technology) were used to model potential applicator inhalation exposures resulting from ground boom applications. Particle size distribution (PSD) for the applicator breathing zone was modeled for each formulation with AGDISP, simulating drift of spray from the nozzle to the edge of the field. A lognormal distribution was fit to the inhalable (<100 μm) portion of the distributions using Crystal Ball and fractional deposition of the resultant spray distribution was modeled in MPPD (fractional deposition in the trachea was used as the best approximation of the larynx – the target site of 2,4-D inhalation toxicity). The fraction of active ingredient aloft at the edge of the field, as determined by AGDISP, was compared between the Enlist and non-Enlist formulations to calculate the additional protection offered by the lower initial driftable fines (leading to a higher rate of herbicide deposition within the field). Fractional deposition in the rat trachea was also modeled, based on the PSD used in the 28-d rat inhalation toxicity for 2,4-D. A rat-to-human fractional deposition ratio can then be used to calculate a human equivalent concentration from the rat LOAEC for use in risk assessment. The very high (>2700) rat:human fractional deposition ratio indicates a low level of risk for laryngeal toxicity in humans following exposure in an agricultural setting. Based on the fraction remaining aloft at the edge of the field, it is estimated that Enlist Duo® may provide up to 2.5-4-fold reductions in applicator inhalation exposures. Potential exposures for both Enlist Duo® and the tank mix result in acceptable margins of exposure.

Keyword:aerosol, exposure models, pesticides

982522

Overview of Machine Learning Methods for Environmental Mixtures

J. Stingone; Columbia University Mailman, School of Public Health, Department of Epidemiology

Abstract: This talk will serve as an introduction to the symposium. It will provide a brief overview of machine learning in general, why it has become of interest in the environmental sciences, and the specific algorithms and approaches that have been used to investigate environmental mixtures.

982522

Advances in Bayesian kernel machine regression for estimating the health effects of complex environmental mixtures

J. Bobb; Biostatistics Unit, Kaiser Permanente Washington Health Research Institute

Abstract: Bayesian kernel machine regression (BKMR) is increasingly being adopted as a tool for estimating the health effects of environmental mixtures. This approach simultaneously estimates the multi-dimensional exposure-response function and incorporates variable selection to identify important mixture components. An R package is available which flexibly implements the methods and provides features for summarizing the multivariate exposure-response surface, including overall, single-exposure, and interactive effects. In this talk, we provide an overview of BKMR, highlight applications that illustrate how the methodology can address different scientific questions of interest, and describe recent advances that generalize the approach to the time-varying exposure and mediation analysis settings.

982522

Bayesian causal inference to quantify benefits and costs of environmental action

A. Keil; University of North Carolina at Chapel Hill, Gillings School of Global Public Health, Department of Epidemiology

Abstract: Given high quality epidemiologic data and prior knowledge, Bayesian causal inference can evaluate the benefits of proposed interventions, including uncertainty. In the case of health outcomes and environmental exposures, numerous analyses have demonstrated advantages to Bayesian approaches for quantifying health effects of one or more exposures. Such effects are not the only input to subsequent decisions, however, as different potential actions on environmental exposures may have varying costs. Standard regression methods, including Bayesian regression, often estimate effects of everyone-versus-none exposed, also known as the average treatment effect, which belies the true public health impact of exposures and the feasibility of acting on them. Cost variability, in a setting of finite public health resources, can yield decisions that do not focus on exposures with the highest average treatment effect but may nonetheless produce the best outcomes for a fixed amount of resources. We demonstrate that intervention costs, when known, can be easily factored into standard Bayesian approaches. We show this approach can be performed as a basic extension to standard epidemiologic analysis with the goal of better using epidemiologic data in decision making under uncertainty.

982522

Practical applications for machine learning and estimating algorithms: From research to policy

A. Krajewski; United States Environmental Protection Agency (US EPA), Office of Research and Development, Center for Public Health & Environmental Assessment

Abstract: Machine learning and estimating algorithms methods have grown in popularity over the several years, which has resulted in a myriad of published research putting these methods into practice. With this growing body of literature lies the opportunity to integrate the knowledge that has been gained through research practice with health assessments, which are used to form policy. This presentation will provide a brief overview of the practical

applications for machine learning in research practice and health assessments, and considerations for integrating into public health policy.

982522
Characterizing extreme heat exposures and their health effects with logic-based metrics: a time-series study of emergency department visits in Atlanta
H. Chang; Emory University, Rollins School of Public Health

Abstract: Short-term associations between extreme heat events and adverse health outcomes are well-established in epidemiologic studies. However, the use of different exposure definitions across studies has limited our understanding of extreme heat characteristics that are most important for specific health outcomes or subpopulations. Logic regression is a machine learning method for constructing decision trees based on Boolean combinations of binary predictors. We describe how logic regression can be utilized as a data-driven approach to identify extreme heat exposures using health outcome data. We evaluated the performance of logic regression in a simulation study, as well as in a 20-year time-series analysis of extreme heat and emergency department visits in the Atlanta metropolitan area. Logic regression identified extreme heat exposures that were associated with several heat-sensitive disease outcomes. Exposures were often characterized by extreme apparent minimum temperature or maximum temperature over multiple days. The simulation study also demonstrated that logic regression can successfully identify exposures of different lags and duration structures when statistical power is sufficient.

982522
Development of Semi-Automated Data Extraction Models for Human Health Assessments
A. Wilkins; United States Environmental Protection Agency (US EPA), Office of Research and Development, Center for Public Health & Environmental Assessment

Abstract: The Environmental Protection Agency (EPA) is working to streamline the human effort required to identify and extract salient data from environmental epidemiology studies and summarize information on study design and results. These streamlining efforts are being achieved by adopting automated and semi-automated processes for data extraction such as Named Entity Recognition (NER) and various machine learning techniques. This presentation discusses an approach for developing extraction algorithms which overviews the 1) use of extraction software tools to annotate studies to create the datasets used to train the extraction algorithms (to identify epidemiologic data of interest), 2) formatting and cleaning the annotated training datasets and 3) evaluation of algorithm performance.

982522
Connecting methods to assessment and policy
K. Rappazzo; United States Environmental Protection Agency (US EPA), Office of Research and Development, Center for Public Health & Environmental Assessment

Abstract: Machine learning and estimating algorithms methods are growing in popularity in research, and several methods and examples have been provided. However, the ways in which policies and regulations are developed may lead to exclusions of this type of research. This presentation will provide a synopsis of what steps are needed to consider these research

studies in creating environmental health policy.

TECHNOLOGY/SENSORS

1054535

Correction for PM2.5 data collected with the PurpleAir sensor in New York, USA and Kintampo, Ghana

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Abstract: PurpleAir, a recently available but worldwide deployed low-cost air quality monitor with approximately 10,000 units that feed data into a near-real time global map of air pollution, can monitor fine particulates (PM) of size <1, 2.5 and 10 μm simultaneously and has all the data publically available. This rapid growing network of PurpleAir sensors has provided numerous continuous PM monitoring data and great opportunities for enhancing the public exposure research. The current calibration methods for PurpleAir data have focused on PM2.5 and are typically through comparing with co-located reference monitoring sites in developed countries. Very few studies have utilized the real-time particle counts at 0.3, 0.5, 1.0, 2.5, 5, 10 μm size fractions from PurpleAir. In this study, we conducted collocated experiments of PurpleAir with real-time monitors including MicroPEM (personal PM monitor, from RTI) with a filter, E-sampler (light-scatter Aerosol Monitor, from Met One Instruments) with a filter, DiSCmini (ultrafine particle counter, from testo, detects 0.01–0.7 μm size range), and UPAS (Ultrasonic Personal Air Sampler, from AST) with a filter in outdoor and indoor settings in rural Ghana and urban greater NYC areas. Both linear regression models and machine learning methods have been performed to improve the correction methods for PurpleAir PM2.5 and PM1 data using temperature, humidity, particle counts and ratios in various size fractions. This pilot investigation can improve PurpleAir PM data quality and contribute to the development of large scale PurpleAir PM data calculation and correction algorithms.

Keyword:air quality sensor, sensor technology, fine particlate matter

1054361

Laboratory and Field Evaluation of a Low-cost Figaro Methane Sensor for Environmental Monitoring in the Mid-Atlantic

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Abstract: Introduction: Methane (CH4) is a greenhouse gas that is 25-times more potent than carbon dioxide. While there is strong interest in monitoring the sources and processes that emit CH4, traditional measurement methods rely on costly federal reference method (FRM) instruments with limited spatial resolution. The rapid development of low-cost sensor technologies provides new opportunities to fill this gap, but uncertainties remain about the deployment of these low-cost instruments across climates and in complex urban environments. This study evaluates the low-cost Figaro TGS 2006 sensor for ambient CH4

monitoring in an urban mid-Atlantic environment. Methods: The Figaro TGS 2600 Taguchi Gas Sensor was evaluated in laboratory and field settings. In the laboratory, 8 sensors were co-located in a controlled laboratory setting to assess inter-sensor variability and evaluated for cross sensitivities in controlled chamber experiments. In the field, a sensor was co-located with a reference instrument (Picarro Cavity Ring Down Spectrometry (CRDS) Analyzer) reporting hourly averaged data in Baltimore, Maryland for 8 weeks in winter (January – March 2020) and 8 weeks in summer (July – September 2020). Two weeks from winter and summer were used as calibration periods while the remaining time was used for validation in a roughly 1:2 ratio. Results/Discussion: The sensors showed strong inter-sensor correlation (R >0.95) and exhibited sensitivities to relative humidity (RH), temperature (T), and carbon monoxide (CO) in calibration experiments. After RH, CO, and hour of day corrections, the sensor reported similar diurnal trends as the reference instrument but exhibited occasional lags during transient plumes (R = 0.60). Despite this, 89% of the sensor readings were within 5% of the reference instrument (~104ppb). Conclusion: This study demonstrated the feasibility of the Figaro TGS 2600 for ambient CH4 monitoring in the mid-Atlantic across a wider range of RH and T values than previously reported. A calibration equation optimized for this sensor across winter and summer seasons is provided and expands on existing evidence surrounding its use in low-cost sensor networks across the US.

Keyword:air sensor, sensor technology, other (specify below), Methane

1054448

Assessing Time Spent in Various Microenvironments in Two Urban Environmental Justice Communities

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Abstract: Collecting real-time data on where people spend their time can increase our understanding of environmental exposures that impact human health. Many studies have characterized time spent in microenvironments using questionnaires and self-reported mobility data, which can introduce recall bias and exposure misclassification. Few studies have utilized time-activity global positioning systems (GPS) data in combination with self-report data to estimate time spent in microenvironments. These data are even more limited for environmental justice study populations. We used GPS and self-reported data to assess time-location patterns during the summer of 2020 for 18 adult residents of Chelsea and East Boston, two environmental justice communities in Massachusetts. Each participant carried a low-cost Bluetooth sensor (Tile Mate) that recorded GPS coordinates every 10 minutes. We used ArcGIS to map participant time-location to buffered microenvironments (i.e., participant homes, green space, and retail stores), and examined trends during weekdays, weekends, and high temperature days (above 80°F and 90°F). GPS results were compared with participant self-reported time-location patterns from a baseline survey conducted on Zoom. Data showed that participants spent an average of 80% of their time in the study area of Chelsea and East Boston. Approximately 75% (35-99%) spent their time indoors at home, with two of 18 participants spending <50% of their time at home and the rest spending >70% of their time at

their residences. When not at home, participants were primarily traveling or in-transit, inside retail stores, or outside in local parks. Trends were consistent across weekdays and weekends, but time spent indoors at home increased during the hottest days. Time spent at home estimated from GPS results was consistent with participant self-reported survey data. High percentages of time spent at home are likely attributable to limited mobility due to COVID-19 physical distancing precautions. We successfully developed methods to capture time spent in microenvironments during hot summer months of 2020. Chelsea and East Boston residents spent 6% more time at home compared to the historical national average (69%), and even more on hot days. These findings support the need for at-home intervention work for extreme heat exposure mitigation strategies in vulnerable communities, particularly during restrictive conditions such as the COVID-19 pandemic.

Keyword:geospatial analysis/GIS, environmental justice, other (specify below), heat

1051655

A new method to estimate ventilation using heart rate

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Abstract: The health effects and exposure dose of air pollution are related to the concentration of pollutants and ventilation (VE). It is difficult to measure VE directly, but due to the high correlation between heart rate and VE, and the easy measurement of heart rate, existing studies have used heart rate to predict VE. However, it is not clear whether the equation between HR and VE obtained from the laboratory cardiopulmonary exercise test (CPET) can be extended to external populations. In addition, such research has not been carried out in China. Therefore, this study established the association between HR and VE among Chinese young people through the CPET experiment, and verified the external validity of the model. Eighty non-smokers aged between 16-21 years old used a bicycle dynamometer to perform an incremental test in which heart rate and minute VE were measured at the same time. Use the data obtained from CPET to construct a linear mixed model. Ten people are randomly selected as the external verification group. The prediction performance was evaluated using an eightfold cross-validation procedure. Monitor the air pollution concentration during CPET and calculate the inhalation load. This is the first study to infer the new equation of the relationship between HR and VE among Chinese young people and verify its external validity. This is very important for evaluating inhalation in future epidemiological studies. However, when estimating VE at the individual level, differences between individuals should also be considered.

Keyword:air pollution, dose, other (specify below), ventilation

1053424

Lead (Pb) exposure assessment in dried blood spots (DBS) using Total Reflection X-Ray Fluorescence (TXRF)

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Abstract: Whole blood remains the most used biomarker for lead (Pb) biomonitoring, however, blood sampling has several limitations, including its invasive nature. Dried Blood Spots (DBS) have been applied as an alternative to traditional methods for decades, but there are gaps that have prevented them to be adopted in biomonitoring programs, such as their small sample volume. There are microanalytical techniques that require a low volume (<10 μL) to perform the analysis, such as Total Reflection X-Ray Fluorescence (TXRF), however, this approach has not been evaluated yet. This study aimed to validate and apply a method to assess Pb exposure in DBS samples using TXRF. First, we developed a method testing different parameters including digestion procedures, an iron extraction, and the use of different internal standards. Next, we validated our method by evaluating several validation parameters, and we compared our results with standardized guidelines. Finally, we applied our method with samples from two population groups. The limits of detection and quantification of the method were 0.28 and 0.69 μg/dL, respectively. The overall precision and accuracy of the method were 14.88 % and 111.14 %, respectively. The Bland-Altman analyses indicated a good agreement between Pb measurements in venous whole blood and capillary DBS. By combining data from the two population groups, there was no significant constant bias (intercept of 0.02 μg/dL) or proportional bias (slope was −0.02) between the two measures, and the lower and upper LoA were −0.86 and 0.91 μg/dL, respectively. These results demonstrate that TXRF is a good alternative to traditional methods for the analysis of Pb in DBS samples and it alleviates challenges such as the low volume of sample, analytical interferences, and sample throughput.

Keyword:lead (Pb), biomonitoring, other (specify below), Method development

TRANSLATIONAL RESEARCH

1052284

Indoor Exposure to Fine Particulate Matter and Practical Mitigation Approaches – Insights from a U.S. National Academy of Sciences Workshop

D. Butler; The National Academies of Sciences, Engineering, and Medicine

Abstract: Particulate matter (PM) dominates the known health impacts of air pollution. Most exposure to PM from both indoor and outdoor sources takes place indoors, a circumstance exacerbated by the COVID-19 pandemic. Exposure to fine PM (PM2.5) is especially concerning because a growing body of research indicates that it is associated with adverse health outcomes, including respiratory, cardiovascular, reproductive, and cognitive effects. In April 2021, the US National Academies of Sciences, Engineering and Medicine webcasted a workshop series on the state-of the-science on exposure to PM2.5 indoors, its health impacts, and engineering approaches and interventions to reduce exposure risks, including practical mitigation steps. The workshop comprised 3 sessions featuring talks from experts on these topics plus roundtable discussions and audience questions. The first workshop session addressed outdoor and indoor sources of indoor PM and included talks on indoor PM of outdoor origin and disparities in sources and exposures across communities; outdoor-to-indoor transport mechanisms and particle penetration; indoor PM chemistry; fine PM

emissions from cooking; secondary aerosol formation of indoor PM; the effect of humidity indoor air chemistry and biology; and the influence of indoor PM sources on the characterization of exposure and evaluation of health effects. It was followed by a session on the health effects of exposure to PM, how that exposure is assessed, and the means of measuring it, featuring talks on the overall health burden of exposure; pulmonary diseases associated with exposure and disparities in economically-challenged communities; the health effects of indoor exposure to wildfire smoke and other ambient air pollution and the building characteristics that mitigate exposure; the state of knowledge on indoor PM measurement science, technology, and policy; moving from PM measurement to gauging occupant exposure; and the utility, use, and misuse of low-cost consumer indoor PM sensors. The final workshop session showcased presentations on the means available to mitigate exposure: PM filtration and air cleaning; exposure control in schools; mitigation of exposures from cooking; portable indoor air cleaners and human behavior; how building occupants interpret and respond to indoor air quality sensors data; and public health responses to reduce community exposure indoors. The presentation will summarize these workshop sessions and address future research plans.

Keyword:built/indoor environment, fine particlate matter, exposure factors

1052679

Chronic environmental contamination: Psychosocial health consequences, risk factors, and pathways to community resilience

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Abstract:A body of psychological and social scientific evidence suggests that the experience of long-term exposure to environmental contamination can be psychologically stressful. Addressing the psychosocial impact in communities living with chronic contamination is therefore a vital part of improving their resilience. We undertook a mixed-methods narrative and systematic review to assess the current research, and provide a platform for future research, on the psychosocial impact of chronic environmental contamination. In addition, we sought to identify strategies for strengthening community resilience to this hazard. In particular, our objectives were to (1) develop a theoretical framework for understanding the unique psychosocial impact of chronic environmental contamination (in contrast to natural and technological disasters, and background pollution); and (2) assess the impact of chronic contamination on psychological health effects. We used a narrative review approach to develop theoretical frameworks for understanding the unique psychosocial impact of contamination, as well as strategies for enhancing community resilience in this context. We adopted a systematic review approach to assess the extent of the psychosocial impact of contamination. This involved a meta-analysis of available findings (k = 60, N = 25,858) from 1995-2019 as a preliminary step and impetus to future improved research. The meta-analysis observed small-to-medium effects of experiencing contamination on general stress, anxiety, depression, and PTSD. Relevant quantitative and qualitative studies were examined to derive a model identifying likely factors increasing risk for psychosocial stress in chronic contamination experience, as well as actions that may be taken by public health professionals and local leaders to enhance community resilience. Relevant risk factors for psychosocial stress include the extent to which community members attribute negative health impacts to

exposures, and the extent to which community concerns are delegitimized by representatives of powerful institutions. Our review suggests that psychosocial stress in the context of chronic contamination is an important potential public health burden and a key area for additional research.

Keyword:community, public health, other (specify below), psychosocial stress

1054453

Drinking Water Challenges at the Nexus of Corroding Infrastructure, Exposure Reduction Science, Regulations and Policy, Public Health and Climate Change

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Abstract: Louisiana faces risks of an oncoming water crisis that will be intensified by both man-made and natural threats. Regional climate models predict an increase in the frequency and magnitude of storms, precipitation, and flooding in Louisiana in the upcoming decades; while at the same time, gaps in regulatory oversight and enforcement, weaknesses public health recommendations for water treatment and testing, and corrosion of drinking water infrastructure threatens delivery of clean water to vulnerable communities. In our investigations, we have come across several cases of private, small or rural water systems which pose public health threats, despite the fact that they have historically complied with regulatory requirements, or conformed to public health recommendations for water system maintenance. In Louisiana, an estimated 400 water systems have excess levels of iron, a largely unregulated nutrient; but monitoring of two compliant systems with high iron revealed conditions which can impact public health. How iron oxides concentrate and mobilize trace inorganics like lead; as well as deplete free chlorine residual, interfere with disinfection, and facilitate propagation of water pathogens is discussed. In New Orleans, while water lead levels met regulatory requirements, prevailing recommendations for reducing exposures through flushing and partial line replacements were not only inconsistently effective, but could also inadvertently increase exposures. Finally, monitoring of wells in the aftermath of historical floods, revealed water pathogen contamination, despite shock chlorination according to prevailing public health guidelines, and lack of pathogen detection using conventional water testing practices. The facts presented, support the need to address vulnerabilities in water regulations, oversight, infrastructure, testing, treatment, and exposure reduction strategies. Ultimately, vulnerable communities that are served by private wells or small rural water systems need low-cost autonomous water treatment solutions in order to prepare for threats they will inevitably face from anticipated climate impacts and infrastructure failures.

Keyword:water, environmental regulation, public health

1094285

Translating Research to Action with Improved Medical Screening Guidance for PFAS

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Abstract:PFAS-REACH (Research, Education, and Action for Community Health) is an NIEHS-funded Research to Action project that is helping support communities impacted by PFAS contaminated drinking water. Affected community members and their physicians have noted medical screening as a high priority need. Therefore, we worked with an advisory team of scientists, physicians, and community members to develop PFAS medical screening guidance documents for residents of PFAS-impacted communities and their physicians that include science-based suggestions about medical screening for PFAS-exposed adults and children who have had known and substantial occupational and/or environmental exposure to PFAS. The documents provide information for affected community members and clinicians that include suggestions for medical screening of health outcomes linked to PFAS exposure as well as discussion points that patients can use to encourage two-way conversations with their doctor. This effort was part of our project mission to develop actionable resources to help protect children's health and support impacted communities in reducing their PFAS exposure and related health risks.

Keyword:environmental health, PFAS, other (specify below), Community Engagement and Research Translation

1055145

Bringing exposure forward in the risk assessment process: case studies in exposure-driven hazard testing

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Abstract: Under the traditional human health risk assessment paradigm, it has been common for toxicity testing to precede estimation of human exposures, with study doses driven by the maximum tolerated dose (MTD, the highest dose not eliciting excessive toxicity in animals). Exposure assessment then follows and often reveals very large margins of exposure (MOE) between the NOAELs in animals and human exposures. Saturable processes in the absorption, metabolism, and excretion of chemicals, leading to non-linear toxicokinetics, limits the applicability of high-dose animal testing to low human exposures. Recently, interest has increased in bringing exposure assessment forward in the risk assessment process driving more relevant hazard and risk assessments. One example of this is the replacement of the MTD with the kinetically-derived maximum dose (KMD, the dose where departure from linearity occurs), allowing for more relevant extrapolation to lower human exposure levels. Where human exposures can be predicted from the outset, this concept can be furthered to include selection of dose levels most relevant to human exposures. Adoption of these practices would limit toxicological effects in animal studies to those most relevant for assessing potential effects of real-world exposures, resulting in improved welfare for test animals. This presentation will explore the potential role for exposure driven testing in

pesticide safety assessments using two case studies: one with nonlinear absorption and one with nonlinear elimination. We will discuss how information on internal and external exposures to each substance could have been used to guide the testing program and will explore potential benefits (e.g., generation of more relevant hazard data, increased welfare of study animals) and drawbacks (e.g., need to "future-proof" an assessment against changes in exposure over time, incompatibility with current hazard-driven regulations) of the approach.

Keyword:risk assessment, dose, other (specify below), Toxicokinetics

1094010
The Role of Misunderstanding and Misapplication of Science in Perpetuating Environmental Injustice
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Abstract: This project documents how differences in available monitoring data, lack of enforceable standards, dismissal of cumulative risks from multiple sources, withholding of vital public health reports, and misunderstanding and miscommunication of epidemiological studies can result in diverging outcomes, opposing conclusions and misleading or confusing public health recommendations. This research aimed to characterize environmental conditions of public schools in St. John the Baptist Parish, Louisiana, US; and compare the results and conclusions with prior government reports and statements of record. Estimates of health risks, both cancer and non-cancer, were derived for children at school locations in the parish. Other data such as biomonitoring data, health statistics, and state investigations were evaluated to determine if community exposures and expected adverse health outcomes are or may be occurring. Air monitoring data, risk estimates and biomonitoring data suggest that environmental concentrations exceed health-based guidelines; while community health statistics support a need for further investigation of potential acute and chronic impacts. Yet government reports and statements indicate that communities are not at risk based on chemical-, and source-specific risk estimates. Given the number of chemicals released, their emitted volumes, and variability in the mixtures residents are exposed to, it is difficult to quantify risk without some degree of error. Gaps also exist in our understanding of long-term health impacts of early-life exposures to different chemical mixtures. Finally, a history of industrial accidents in the area, and audit determinations documenting lax state regulatory oversight, enforcement, and risk communication, should propel officials to take more precautionary actions, as potential lifelong impacts on developing children could outweigh short-term economic benefits provided by industry.

Keyword:risk assessment, public health, environmental health

USE OF "BIG DATA" IN EXPOSURE SCIENCE

1092157
Assessing workers' exposure to complex chemical mixtures
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Abstract: Many chemical products used at workplaces, such as paints, lacquers or lubricants contain hazardous volatile components, which upon inhalation may lead to associated health risks. In general, exposure levels to vapors depend on the specific use of the chemical product (e.g. temperature, type of application), and the physicochemical properties of the components (e.g. solubility, miscibility, and volatility). For instance, when the operating temperature leads to evaporation of some less hazardous components, the concentration of the remaining more hazardous ones is increased, which in turn may increase their volatility and lead to increased inhalation hazards. Or, when a product is reactive, the mixture composition changes with time, which influences the activity of all components. To examine such inhalation risks, the concentrations of the evaporating hazardous components in the air needs to be assessed based on their vapor pressures. Vapor pressure or equilibrium vapor pressure is defined as the pressure exerted by a vapor in thermodynamic equilibrium with its condensed phase (solid or liquid) at a given temperature in a closed system. The equilibrium vapor pressure is an indication of a liquid's (or solid's) evaporation rate. It relates to the tendency of particles to escape from the liquid (or solid). A substance with a high vapor pressure at normal temperatures is often referred to as volatile. As most products are mixtures, it is not sufficient to know the vapor pressure of the components in their pure forms, but the so-called partial vapor pressure of the components in the mixture needs to be determined. To this end, the type of application and the interactions of the components with each other need to be considered. That will be done by calculating the vapor pressures based on the concentrations of the components in the mixture and the activity coefficients. The activity coefficient is a factor used in thermodynamics to account for deviations from ideal behavior in a mixture of chemical substances.

Keyword:exposure models, workplace, risk assessment

1054674

Interpretable Machine Learning for Exposure Science Applications

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Abstract: Spatial linear Land-Use Regression (LUR) has been commonly used for long-term modeling of air pollution in support of exposure and epidemiological assessments. In recent years, Machine Learning (ML) techniques, combined with big data sets that aggregate ground monitor measurements, satellite observations, multiscale model outcomes, etc., are gaining popularity as tools for modeling complex patterns of air pollution that are highly variable in space and time. However, training reliable Machine Learning models requires a careful design of model architecture (hyperparameter tuning) and targeted data splitting and validations. Furthermore, ML models are "black-box" formulations and currently there is a lack of interpretation tools, that are needed to establish model transparency that would be comparable to Land-Use Regression. In order to improve the robustness and interpretability of Machine Learning tools for exposure applications, we developed a Bayesian Ensemble Machine Learning (BEML) framework, that selects base learners from 13 types of statistical and machine learning models fusing heterogeneous spatiotemporal information. Here we present applications involving downscaling of ozone daily max 8hr average (DM8HA)

predictions from the Community Multiscale Air Quality model (CMAQ) at 12x12 km2 horizontal resolution, to census tract level, across the contiguous US (CONUS). We incorporated three-stage hyperparameter tuning and flexible validations to ensure our framework's ability to interpolate, extrapolate, and capture concentration peaks. We introduced global interpretation tools such as the variable importance metric, partial dependence plot, independent conditional expectation, and variable interaction metric to interpret captured nonlinear relationships, heterogeneous associations and complex interactions; also, we included local interpretation tools, such as the Shapley value, to explain drivers of concentration gradients. Performance of the predicted fine scale spatiotemporal surfaces was compared to that of alternative methods, i.e. the LUR approach and the EPA downscaler. Furthermore, our framework, trained with CMAQ outcomes and data for 2011, was evaluated for its ability to predict fine scale concentrations over the period 2012-2017, and then used to estimate local (census tract) ozone concentrations from low resolution CMAQ outcomes from a year 2051 simulation that takes into account effects of climate change on photochemical air pollution.

Keyword:air quality, big data, other (specify below), machine learning

1054666
Metadata Driven Approaches to Semantically Consistent Exposure Health Research Infrastructure
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Abstract: Exposure health studies and the exposome comprise of multiple domains of data. Each domain of data can be sourced from different collection methods and approaches. Utilizing these data is therefore met with semantic complexities and a need for harmonizing them. Many efforts have been initiated to have a consistent language for describing data and information relevant to the exposure health. Most current approaches to data harmonization are human driven and resource intensive. Also there are a diverse variety of exposure health studies and uses of the exposome. Most importantly the data used in these studies covers a large number of real world and study specific variables including sensor-based, clinical, biospecimen derived, aggregate, and computational modeled sources. In order to address these challenges, we have developed a metadata centric approach in harmonizing and integrating big data resources for exposure health studies. In this multi-tiered approach to modeling the exposures and the exposome, we harmonize data at higher levels categorizing in sensor-based, clinical, biospecimen derived, aggregate, and computational modeled domains. We describe metadata for each of these domains consistently and use that to integrate data as spatio-temporal events. Depending on the use case, with the entities and attributes already harmonized at the metadata level, values are then harmonized as seem fit. In this presentation we will provide examples of this metadata driven model for semantically consistent utilization of exposure data. For example, the meta-model for a sensor recording will need to have a description of the sensor, the species being measure by the sensor, the units of measure of the recording, a time and location stamp. We will discuss how this approach is agnostic to the domain of data and applicable to all exposure health study archetypes.

Keyword:big data, artificial intelligence (AI), other (specify below), Metadata, Semantics,

Data Integration

1054686
Spatial and temporal variations in indoor radon concentrations in Pennsylvania, USA from 1988 to 2018
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Abstract: Indoor radon exposure is the second leading cause of lung cancer in the United States. Indoor radon concentrations vary depending on the geology and season. In this study, we analyzed over 2.6 million indoor radon measurements in Pennsylvania from the years 1988 to 2018. The main objectives are to investigate seasonal, annual, and spatial variation of indoor radon concentrations, and to identify radon hotspot areas throughout the state of Pennsylvania. We found that indoor radon concentrations in Pennsylvania have been decreasing over time, and indoor radon concentrations varied by building type and floor levels. Based on a total of 1.8 million radon tests conducted on ground and first floor from 1988 to 2018, we found that 61% of the area (by zip codes) had higher radon levels than US EPA action level concentration of 148 Bq/m3 (equivalent to 4 pCi/L). Winter and fall had significantly higher indoor radon concentrations than summer and spring. Hotspot analysis by ArcGIS showed that the two main urban centers, Philadelphia and Pittsburgh, were not the areas with high indoor radon levels. Among the three main cities in Pennsylvania, Harrisburg (227.18 ± 247.9 Bq/m3) had the highest indoor radon levels compared to Philadelphia (82.14 ± 89.54 Bq/m3) and Pittsburgh (144.67 ± 156.51 Bq/m3). We also found that single level homes had the highest indoor radon levels.

Keyword:radon, air, built/indoor environment

1054434
A Nationwide High Resolution Spatiotemporal Fine Particulate Matter Exposure Assessment Model
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Abstract: The relationship between particulate matter less than 2.5 μm (PM2.5) and health effects has increasingly been studied at higher temporal resolutions in larger studies, highlighting the need for accessible, high resolution, and nationwide exposure assessment models. We used PM2.5 measurements to create a nationwide, daily PM2.5 prediction model covering 2000 until 2021 at a 0.75 sq km resolution. We utilized an existing hexagonal hierarchical spatial index specifically to minimize geographic distortion and to simplify geographic lookups at different spatial precisions. We created a novel approach that utilizes a single bagged learner with a complete training dataset to create leave-one-location-out cross validated (LOLO CV) estimates of model accuracy instead of requiring computationally-intensive repetitive model training on data subsets or resamples. This allowed us to characterize LOLO prediction error for different temporal resolution (e.g., daily, weekly, monthly, annual) and geographic regions, instead of using one error statistic to summarize model performance. Further, this approach was adapted to a generalized random forest to

allow for 95% prediction confidence intervals. We considered 43 predictors, including data from the Multi-Resolution Land Cover Database, the North American Regional Reanalysis, Moderate Resolution Imaging Spectroradiometer measurements, the National Emissions Inventory Database, the American Community Survey, and a Daily Fire Emissions product. Using a variable importance metric, we selected 8 predictors that were able to accurately predict daily PM2.5, with an overall LOLO CV median absolute error (MAE) of 1.20 μg/m3, an R2 of 0.84, and a confidence interval coverage fraction of 94%. When considering aggregated temporal windows, the model achieved LOLO CV MAEs of 0.99, 0.76, 0.63, and 0.60 μg/m3 for weekly, monthly, annual, and all-time exposure assessments, respectively. This work represents the first PM2.5 exposure assessment model with confidence intervals for predicted concentrations and will allow for uncertainty propagation from exposure assessment to health effects models. Furthermore, the hexagonal hierarchical spatial index was designed to minimize quantization error introduced when people move throughout cities, making this exposure assessment tool ideal for utilizing high resolution GPS or travel activity data in order to assess high resolution daily ambient PM2.5 exposures for health effects studies.

Keyword:exposure models, fine particlate matter, statistical methods

1054293

Efficient and Secure High Resolution Spatiotemporal Exposure Assessment

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Abstract: High resolution spatiotemporal interpolation and prediction models are increasingly common, but their practical usage for exposure assessment is hindered by (1) large data files sizes or long computation times, (2) the need for technical expertise to implement in new study populations, and (3) privacy restrictions around sharing relatively precise spatiotemporal locations of study participants. We extended the free and open-source DeGAUSS (Decentralized Geomarker Assessment for Multi-Site Studies) framework to deal with gridded spatiotemporal datasets, allowing for decentralized, private, and reproducible exposure assessment. This approach only downloads the coarse spatiotemporal slices of data needed for exposure assessment, significantly reducing the size of exposure data that needs to be transferred. Specifically, spatiotemporal gridded data is broken into smaller files based on their geohash and calendar year, allowing us to satisfy HIPAA's Safe Harbor definition of deidentified data. We have implemented this methodology within the NIH-funded ECHO (Environmental Influences on Child Health Outcomes) study to obtain high resolution, daily exposure estimates for three different ambient pollutants. The software approach was validated by comparing exposure estimates at random locations and dates created by different software and users. While the entire set of 1 km x 1 km nationwide daily pollutant estimates from 2000 to 2016 is over 2 TB in size, our method frequently only required downloading data two orders of magnitude smaller. In a follow up survey, five of seven respondents indicated that installing the software was either "easy" or "very easy" and six of seven respondents indicated that using the software "easy" or "very easy", specifically noting that DeGAUSS provided results quicker than other methods they have used, with an average usability score of 90.5. This approach to sharing spatiotemporal exposure assessment models makes them portable and reproducible, satisfying the recent acceptance and implementations

of FAIR (findable accessible, interoperable, reusable) data principles and efforts to mobilize computable biomedical knowledge. As a free and open source software package, we encourage others to utilize this framework for any spatiotemporal exposure assessment.

Keyword:air pollutants, geospatial analysis/GIS, big data

1054549

High-resolution metabolomics of exposure to tobacco smoke during pregnancy and adverse birth outcomes in the Atlanta African American Maternal-Child cohort

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Abstract: Background: Exposure to tobacco smoke during pregnancy has been associated with a series of adverse reproductive outcomes; however, the underlying molecular mechanisms are not well-established. To help close this gap, we conducted an untargeted metabolome-wide association study (MWAS) to identify the metabolic perturbations and potential biomarkers underlying the association between cotinine, a widely used biomarker of tobacco exposure, and adverse birth outcomes. Methods: We collected early and late pregnancy urine samples for cotinine measurement and serum samples for high-resolution metabolomics (HRM) profiling from 105 pregnant women from the Atlanta African American Maternal-Child cohort (2014-2016). Maternal metabolome perturbations mediating prenatal tobacco smoke exposure and adverse birth outcomes were assessed by an untargeted HRM workflow using generalized linear models, followed by pathway enrichment analysis and chemical annotation, with a meet-in-the-middle approach. Results: The median maternal urinary cotinine concentrations were 5.93 ug/g creatinine and 3.69 ug/g creatinine in early and late pregnancy, respectively, with a total of 29 women having concentrations higher than 100 ug/g creatinine. In total, 16,481 and 13,043 metabolic features were identified in serum samples at each visit using liquid chromatography-high resolution mass spectrometry with positive and negative electrospray ionization (ESI) modes, respectively. Thirteen metabolic pathways were found to be associated with cotinine concentrations and adverse birth outcomes during early and late pregnancy, including tryptophan, histidine, urea cycle, arginine, and proline metabolism. We confirmed 47 metabolites associated with cotinine levels, preterm birth, and shorter gestational length, including glutamate, serine, choline, and taurine. These identified metabolites are closely involved in endogenous inflammation, vascular reactivity, and lipid peroxidation processes. Conclusions: The metabolic perturbations associated with cotinine levels were related to inflammation, oxidative stress, placental vascularization, and insulin action, which could contribute to shorter gestations. These findings support the future development of targeted interventions to reduce adverse birth outcomes associated with tobacco smoke exposure, especially among African American women who are disproportionately exposed to high tobacco smoke and experience higher rates of adverse birth outcomes.

Keyword:environmental tobacco smoke (ETS), metabolism, other (specify below), Preterm

birth

1054550
The Oxidative Potential of Fine Particulate Matter and Biological Perturbations in Human Plasma and Saliva Metabolome
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Abstract: Background: Exposure assessment and health impact evaluation of particulate matter (PM) mixtures remain very challenging. Fine particle oxidative potential (FPMOP) has been considered as a key health-relevant particulate parameter. We measured FPMOP exposures in a recent panel study and corresponding metabolic perturbations to evaluate its potential epidemiologic value and examine molecular mechanisms underlying PM-related health impacts. Methods: We recruited 54 participants from two dormitories in Atlanta, GA near and far from a congested highway. Indoor or outdoor FPMOP levels at the dormitories were measured using dithiothreitol (DTT) assay. Plasma and saliva samples were collected from participants at four time points during 12 weeks. Liquid chromatography coupled with high-resolution mass spectrometry was used to profile the participants' metabolome. We used mixed effect models to examine associations between metabolic features and FPMOP, controlling for potential confounders including age, gender, race, and body mass index. Significant metabolic features meeting false positive discovery rate at 20% were used for pathway enrichment analysis and metabolite annotation. Results: The 96h-mean water soluble FPMOP levels at the near and far dormitories prior to biosample collection were 26.3 and 22.9 nmol/min/μg, respectively. In total, we extracted 20,766 metabolic features from plasma samples and 29,013 from saliva samples. Purine metabolism, N-glycan biosynthesis, and beta-alanine metabolism were most strongly associated with 5 or more FPMOP-related measurements in plasma, while vitamin E metabolism, leukotriene metabolism, and glycosphingolipid metabolism were found associated with FPMOP in saliva. We confirmed 6 metabolites directly associated with FPMOP measurements with level 1 evidence, including hypoxanthine, histidine, pyruvate, lactate/glyceraldehyde, azelaic acid, and petroselinic acid/elaidic acid/oleate, which were implications of perturbations in amino acid, carbohydrate, nucleotide and lipid metabolism. Conclusions: We identified metabolites and pathways perturbations in plasma and saliva following by higher FPMOP exposure in panel-based setting. Perturbations in amino acid, carbohydrate, nucleotide and lipid metabolism may elicit PM-related health impacts.

Keyword:fine particlate matter, metabolism, biomarkers

1054573
Initial Observations on Day- and Night-Concentrations of Ozone, PM 2.5 and PM 10 using EPA Air Quality Monitoring Data
S. Liu; US EPA

Abstract: Over the past decades, the US Environmental Protection Agency (EPA) has obtained a large amount of monitoring data on selected air pollutants (i.e., ozone, PM 2.5 and

PM 10) that comprise the Air Quality Index (AQI). These hourly-monitored air pollutant concentrations are aggregated into daily averages and used for calculating the AQI for each day. However, air pollutant concentrations may vary between day and night and people may experience different exposure levels to these air pollutants when their working and resting places show some day-night differences in air pollutant concentrations. Thus, separating day and night concentrations may be necessary for refined exposure assessment. Each hourly-based monitoring data from EPA's Air Quality System (AQS) database was individually assigned to a day (8 AM to 6 PM) or a night (6 PM to 8 AM) according to its monitor's local time. Then the day and the night concentrations of selected AQI pollutants were calculated and analyzed using Python-based big-data analysis programs. The initial analysis utilized 2019 monitoring data and showed clear differences between the day and the night concentrations in ozone, PM2.5 and PM10. Based on millions of records, the mean USA day concentration of ozone was 0.04 ppm which is higher than mean night concentration of 0.02 ppm. Interestingly, the mean USA day concentration of PM2.5 (6.85 ug/m3) was lower than its mean night concentration (7.58 ug/m3). The day and the night mean concentrations of PM10 were close with 20.23 ug/m3 for day and 19.32 ug/m3 for night. Further analysis showed that the day/night ratios of ozone, PM2.5 and PM10 varied among different states / territories of USA. Detailed inspections on these variations in selected three states (California, New York, and North Carolina) showed that heterogeneities exist among different counties within each state. Monitor-based analysis showed that some variations even exist within the same county. This preliminary analysis indicates a need for considering day and night concentrations for ozone, PM2.5 and PM10. Monitor-based values of these day-night differences in air quality may be useful for refined exposure assessment for people who work and reside in different locations that have some day-night differences in air pollutant concentrations.

Keyword:air quality, big data, exposure factors

1054555

Potential predictors of chemical occurrence in biosolids for a screening-level consensus model

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Abstract: Municipal wastewater treatment in the United States produces an estimated 8 million tons of biosolids yearly. Anthropogenic chemical contaminants in wastewater may accumulate in biosolids. Thus, biosolids (land-applied, placed in landfills, or incinerated) are of interest as a potential pathway of human and environmental chemical exposure for risk-based chemical screening and prioritization. The U.S. EPA publishes biennial reports identifying chemicals found in biosolids. However, measurements of chemical concentrations in biosolids are limited. Moreover, thousands of chemicals are produced or used in the U.S. in high volumes; for most of these, occurrence in biosolids has not been assessed. Methods are needed to rapidly predict chemical concentrations in biosolids for substances with limited data. As a first step towards developing an in silico screening-level consensus model, we identify potential predictors of biosolids chemical occurrence. The predictors consist of

various previously-published data sets and computational models, which describe chemical entry into the wastewater stream and/or chemical fate during wastewater treatment. Previously-published data sets serve as predictors by providing measured data from which we may infer unknown chemical concentrations in wastewater and biosolids, such as measurements of chemical concentrations in water or wastewater, or reports of per capita chemical use. Similarly, the results of previously-published computational models serve as predictors by providing estimates of quantities from which we may infer unknown chemical concentrations in wastewater and biosolids, such as predicted amount of chemical down-the-drain per person per day, or chemical biodegradation rate during wastewater treatment. Potential predictors are organized according to which stage(s) of the urban water cycle they describe. Data requirements (for models) and domain of applicability (for both models and data) are characterized. This database of potential predictors will clarify data availability and data needs for prediction of chemical occurrence and potential exposures through biosolids. The views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

Keyword:exposure models, big data, other (specify below), biosolids

1054462

Investigating public health research decision-making using artificial intelligence: A case study of Pb literature

N. Grokhowsky, L. Stanek; U.S. EPA, Office of Research and Development, Center for Public Health and Environmental Assessment

Abstract: Systematic reviews can identify novel approaches and synthesize scientific literature on a given topic, but they are time consuming and do not account for research bias. Modern techniques using natural language processing (NLP) and its sub-field, name entity recognition (NER), paired with other machine learning and statistical analysis, can expedite the time for a systematic review with little to no increase in error. Additionally, with hundreds or thousands of articles to review, these tools can be used to account for biased research. Geography is ideal for calculating potential biases as it inherently contains non-randomly distributed, confounding factors. Therefore, we designed and explored a methodology for extracting geographical locations from journal articles using NER, and the analysis of these articles by location to identify what factors cause research bias. This approach was applied to childhood lead (Pb) exposure literature as a case study. Using multiple existing NLP toolkits, we built a geographic extraction methodology to identify the U.S. state where research was performed. A literature search of childhood Pb exposure identified 1,061 U.S.-based journal articles that fit pre-determined selection criteria. In more than 20% of the articles, our methodology accurately extracted the U.S. state where research was conducted. The U.S. states were manually validated, with accuracy and precision calculations greater than 90%. The journal articles were grouped by state, and the article frequencies were calculated. State level features were joined to this data set for analysis. Regression analysis and random forest analysis was calculated using article counts as the dependent variable. The results were displayed as maps of the significant over-predictions and under-predictions of article counts. In this context, biased research is defined as an over or under estimate of research, in a given state, based on the variables used for modeling. The

maps identified multiple states that were significantly biased within this body of research, and causal effects were identified by the selected model variables. These artificial intelligence and machine learning tools can aid public health researchers in efficiently conducting systematic reviews with large bodies of research. This process gives researchers the ability to identify research locations that are less likely to be influenced by outside sources and where substantial data gaps exist.

Keyword:lead (Pb), children, artificial intelligence (AI)

1054469

Using experimental animal data from ToxValDB to derive points of departure for application in LCIA and comparative risk screening

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Abstract: Life cycle impact assessment (LCIA) and comparative risk screening rely on chemical-specific points of departure (PODs) from regulatory toxicity data sources to evaluate toxicological impacts on human health from chemical exposures. However, regulatory PODs are not available for the majority of chemicals to which humans can be exposed. We thus aim to broaden the coverage of chemicals by using available in vivo data to estimate PODs that most closely mimic one that would be selected in a regulatory assessment context. As a starting point, we extracted and curated experimental animal data available from the US EPA ToxValDB, focusing on oral repeated-dose studies and three non-cancer effect-level types: lowest observed adverse effect level (LOAEL), no-observed adverse effect level (NOAEL) and benchmark dose lower bound (BMDL). The curation process included harmonization of units into mg/kg-d followed by extrapolations from subchronic or subacute studies to chronic, from different effect-level types to benchmark dose (BMD) and from tested animal species to humans. After curation, in the case of data-rich chemicals with at least 10 data points, we fit the resulting data to a lognormal distribution. For data-poor chemicals with less than 10 data points, we fit the distribution while applying a fixed standard deviation of log10=0.55, based on the average standard deviation across data-rich chemicals in our curated dataset. PODs were then derived for 9037 chemicals based on the 5th%-ile of the fitted lognormal distribution. The resulting POD values ranged by orders of magnitude from 1e-7 mg/kg-d to 1e4 mg/kg-d across the considered substances, with a median POD=7 mg/kg-d. For the 746 chemicals with available regulatory PODs, we observed a good correlation with our derived 5th%-ile PODs (R2=0.70 and RMSE=0.64 of the log10-transformed values). These results suggest that the proposed method is able to derive PODs consistent with regulatory values in a high-throughput approach, thus substantially increasing the coverage of chemical substances for application in LCIA and risk screening. Next steps include using this curated dataset to train a machine-learning-based prediction model to estimate PODs for an even wider range of substances without any experimental animal data available. This abstract does not necessarily reflect US EPA policy.

Keyword:lifecycle analysis, risk assessment, other (specify below), Point of departure

1054499
Harnessing information and communications technologies (ICT) data and artificial intelligence (AI) in exposure science and environmental health studies
M. Nyhan, A. O'Regan; National University of Ireland - University College Cork

Abstract: With the recent digital revolution and advances in both computer vision and artificial intelligence (AI) methods, new approaches to the study of the urban environment, urban environmental exposures and health impacts have emerged. There is an urgent need to harness these new approaches in related to urban air pollution research and policy. Furthermore, in order to manage urban greenspace infrastructure in cities worldwide and unlock its full socio-economic and health benefit potential, an improved understanding of urban greenspace metrics is urgently required. Our research has shown that information and communications technologies (ICT) can be used to quantify human mobility patterns and environmental exposures of entire urban populations. Studies conducted in New York and Boston highlight the potential of using largescale cellular network data in population-level particulate matter air pollution exposure assessments. In addition to this, the authors have quantified street-level greenspace metrics in high spatial resolution using almost a million Google Street View images and computer vision methods across three major cities in Ireland. The impact of greenspace exposures on socio-economic and health determinants within and between these three urban areas were also examined. The findings will inform urban planning and policies for improving environmental health in rapidly urbanizing cities worldwide.

Keyword:air pollution, environmental health, other (specify below), urban; greenspace; ICT data; environmental exposures; emerging technologies

1047014
Fusing big data for precise exposure and health risk assessment
w. Che, A. Lau; The Hong Kong University of Science and Technology

Abstract: Numerous cities are installing “smart” infrastructure or monitoring systems. Big data generated from low-cost smart sensors and high-resolution models enable new approaches to characterize and manage urban air pollution, and personal exposure to air pollutants, for improved public health protection. We present an example of how to fuse existing and new sensors with state-of-the-art modelling tools and big data analytics to quantify and forecast street-level air quality. The example is based on Hong Kong. The methodological approach is on detailed land-use and urban morphology, weather, traffic and other emission information. Current and predicted spatial variability in air quality and health risk are provided to citizens through a smart-city mobile phone app, Personalized Real-time Air-quality Informatics Systems for Exposure – Hong Kong (PRAISE-HK) (http://praise.ust.hk). Large-scale air quality variation is quantified in PRAISE-HK by coupling Weather Research and Forecasts (WRF) and Community Multiscale Air Quality (CMAQ) modeling systems, with the latter nested down to 1km by 1km. In the complex morphology of the Hong Kong urban environment, which includes 355 skyscrapers (the most

of any city globally), Urban Atmospheric Dispersion Modelling System (ADMS-Urban) is used to quantify steep concentration gradients in street canyons and other complex terrain by incorporating urban morphology and variations in vehicles simulated using the Multi-Agent Transport Simulation (MATSim) model. MATSim is configured for the Hong Kong road network including 4 million users, 8,797 nodes and 18,207 links. Big data analytics are used to incorporate real-time traffic, air quality and weather data to correct for factors not captured by the modeling system, such as short-term local changes in traffic emission caused by traffic jams. High resolution air quality predictions from the WRF/CMAQ/ADMS-Urban system have 20% to 30% higher index of agreement (IOA) for NO2 compared with WRF/CMAQ alone. With further enhancement from big data analytics, the complete PRAISE-HK system, has IOAs over 0.80 for all simulated pollutants in both winter and summer. The PRAISE-HK project is a solid example of how to combine smart sensor information with conventional domain expertise to provide real-time and highly accurate and valuable information to individual citizens to help reduce their air pollution exposure and the related health impacts.

Keyword:big data, air pollution, air sensor

1053337

Air pollution and type 2 diabetes: a comparison between rural and urban populations

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Abstract: Background In previous work, we successfully used machine learning to characterize air pollution profiles and explore how they relate to type 2 diabetes mellitus incidence in the US. We used stationary US Environmental Protection Agency (EPA) air quality monitors to associate health effects with air pollution at the county level. However, these monitors tend to be located in population dense areas and are limited in rural counties. The aim of this research is to use the same machine learning method to associate the health effects with air pollution data estimates from EPA monitors and satellites in order to include AQ exposure estimates for a larger proportion of the US population. This research will determine the suitability (i.e., fit-for-purpose) of satellite instrument data in qualitatively representing air pollution exposure. Methods The EPA monitors and NASA satellite instruments collect data on daily PM2.5, SO2, NO2, and CO concentrations. This multidimensional data will be partitioned using an unsupervised machine learning method, k-means clustering, to create air pollution profiles. The first analysis will compare the clustering of daily air pollution measurements (for counties represented in both sources) when using the EPA monitors vs. satellite instruments to determine whether days cluster similarly and satellite data are fit-for-purpose. A second analysis, using the satellite instrument data will be expanded to include all US counties, which will be matched to diabetes incidence data from the US Centers for Disease Control and Prevention for the year following air pollution exposure. Additionally, urban and rural areas will be compared to explore whether differences exist. Results We expect that EPA monitors and NASA satellite instruments associations with diabetes will be highly correlated and that the expansion of the data to rural counties will support prior findings of increased type 2 diabetes incidence with higher levels of air pollution in both rural and urban counties. Conclusions Chronic exposure to air

pollution is known to cause systemic inflammation, adiposity, and insulin resistance thereby increasing the risk of type 2 diabetes. However, there is limited air pollution monitoring in rural areas by the EPA in 79% of counties across the US, accounting for approximately 30% of the US population. The use of satellite instruments to detect and monitor air pollution could improve exposure assessments for those living in rural areas.

Keyword:air pollution, environmental health, big data

1054232

Residential bacteria and fungi identified by high-throughput sequencing and childhood respiratory health

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Abstract: Background: The objective of this study was to examine and compare the bacterial and fungal microbiomes and respiratory health outcomes at ages 7 and 12. Methods: In-home visits were conducted in 2010 at age 7 for children enrolled in the Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS). Floor dust was collected and analyzed by bacterial (16S rRNA gene) and fungal (internal transcribed spacer region) sequencing. Respiratory outcomes included asthma and wheeze at ages 7 and 12. The associations between home exposure and respiratory outcomes were evaluated for 170 children using univariate analyses, Permanova, DESeq, and weighted quartile sum (WQS) regression models. Four types of WQS regression models were run, for protectively and adversely associated fungi and bacteria. Results: When comparing alpha or beta diversity of fungi and bacteria across respiratory health outcomes, no significant associations or differences were found. Twenty specific fungal and 15 bacterial species were found to be protectively associated, whereas 2 fungal and 5 bacterial species were adversely associated with asthma and wheeze. WQS regression models for asthma and wheeze determined varying mixtures of fungal species to be protectively and adversely associated with health effects (adjusted odds ratio [aOR] range = 0.69 - 0.84; 95% confidence interval [CI] range = 0.6 - 0.7, 0.9 - 1.0, and aOR range = 1.22 - 1.34; CI range = 1.1 - 1.2, 1.4 - 1.6, respectively). Bacterial WQS regression models found mixtures of bacterial species to be protectively associated with age 7 asthma and wheeze (aOR = 0.76; CI = 0.6, 0.9 and aOR = 0.84; CI = 0.7, 1.0, respectively), and adversely associated with age 12 asthma and wheeze (aOR = 1.16; CI = 1.0, 1.3 and aOR = 1.17; CI = 1.0, 1.3, respectively). Weights for specific species within WQS regression models supported the indicator taxa findings. Conclusion: Weighted quartile sum regression models demonstrated that specific mixes of fungal or bacterial species can have protective or adverse associations for asthma and wheeze. Individual species were also identified to be protectively or adversely associated with health effects. The bacterial and fungal indoor microbiomes need to be considered when evaluating potential health effects of the indoor environment.

Keyword:built/indoor environment, microbial agents, respiratory health

1054096

Air Pollution Exposure and its Application in Health Studies

T. Li; National Institute of Environmental Health, Chinese Center for Disease Control and Prevention

Abstract: Air pollution causes health hazards in both long- and short-term exposure. The study of chronic health effects---cohort studies started late in China, and the previous researches mainly relied on foreign exposure datasets. For studies of acute health effects, including time series, case-crossover and panel studies, mainly used exposure data from the nearest monitoring sites. The monitoring sites are unevenly distributed, which can lead to exposure bias. We designed the Sub-Clinical Outcomes of Polluted Air in China (SCOPA-China) Cohort, to examine sub-clinical outcomes of long-term exposure to PM2.5, O3, PM2.5 components, particle sizes and other air pollutants and related biological mechanisms. The study recruited 5864 participants from fifteen provincial-level administrative areas, which is close to the environmental monitoring site (1–25 km), and has a permanent resident population of 10,000 or more. Varied exposure assessment methods were applied to fill in the deficiencies of existing researches. We established high-performance random forest models with 1km resolution to provide historical PM2.5 and O3 concentration during 2005-2017. Furthermore, we established a web-based real-time personal PM2.5 exposure monitoring system (RPPM2.5 system), which collects data of outdoor PM2.5 concentration, indoor PM2.5 concentration and real-time location from wearable device, and finally evaluates personal exposure of participants. The high-precision exposure dataset can be further applied in the future. First, the multiple exposure datasets can be evaluated by epidemiological studies; second, high-precision exposure datasets from varied resource can be integrated to reduce the uncertainty of health risk assessment; furthermore, the datasets can be further used in public health services related to air pollution.

Keyword:air pollution, big data, risk assessment

1054013

Spatial autocorrelation of air pollutants at a small-district in Seoul, Korea using in-situ measurement

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Abstract: Exposure to air pollutants has significantly linked to be increased acute and chronic health effects. Application of air quality monitoring station (AQMS) data as a proxy of exposure to air pollutants can cause classification error by spatial-temporal variation of ambient air pollution. Identification of spatial autocorrelation of ambient air pollution can be useful to mitigate the error of air pollution estimation at un-monitored area. The study aimed to identify spatial autocorrelation of five air pollutants (PM2.5, PM10, NO2, CO, and O3) at small-scale areas in Seoul, Korea in four seasons. Real-time hourly concentrations of five air pollutants were obtained from one AQMS and eight in-situ monitoring sites (IMS) with each area of 1 km2 surrounding the AQMS at Guro-gu. All monitoring sites were equipped with

the national standard method monitors for the air pollutants. Global and local spatial autocorrelation were determined using Moran's index analyses. The high concentrations of particulate matter (PM) were observed in winter, while high O3 levels in spring and summer. The mean concentrations of PM10 and CO at IMS were significantly higher than at AQMS in four seasons. PM and NO2 in winter had close to zero of global Moran's index (GMI) while O3 in spring and autumn had a positive GMI. The wide variations of local spatial autocorrelations were observed in each monitoring site. PM had generally a negative local spatial autocorrelation while O3 had a positive local spatial autocorrelation in each monitoring site. Spatial-temporal variation with relatively high resolution of 1km2 was identified in smaller area based on real-time in-situ measurements over one year. The results provided a basis understanding of seasonal spatial variations for air pollutants. Seasonal spatial variation of air pollutants should be applied on methodologies of exposure estimation of air pollution.

Keyword:air pollutants, air pollution, spatial, autocorrelation

1053792

The Residential Population Generator (RPGen): parameterization of residential, demographic, and physiological data to model intraindividual exposure, dose, and risk.

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Abstract: Chemical exposure is frequently characterized using models bound by time, location, and activity. These models require inputs that describe communities, homes, and individuals. Therefore, models with granular descriptions of populations are better equipped to estimate exposure and dose. The Residential Population Generator (RPGen) assembles a synthetic population from three United States (U.S.) surveys and the R Package httk for use in models of intraindividual probabilistic exposure and dose. The final modeled population data parameters include characteristics of the individual's community (region, state, urban or rural), residence (size of property, size of home, number of rooms), demographics (age, ethnicity, income, gender), and physiology (body weight, skin surface area, breathing rate, cardiac output, blood volume, and volumes for body compartments and organs). To demonstrate RPGen, a run of the Consolidated Human Exposure Model (CHEM), of which RPGen is the first module, is compared to output from the Stochastic Human Exposure Dose Simulation - High-Throughput (SHEDS-HT), a cross sectional model for 1-day exposure predictions across a population. Both estimates are validated across the CompTox dashboard daily exposure predictions, which are estimated using the Systematic Empirical Evaluation of Models (SEEM), an integration and evaluation framework which calibrates model estimates against NHANES biomonitoring data. For both SHEDS-HT and CHEM, a case example with similar product use categories is performed. The results demonstrate that the RPGen population, when integrated in a model, provides determinants for exposure which inform product use. In addition, by creating profiles and characteristics that determine exposure, RPGen allows modelers to simulate data-driven populations and identify those potentially vulnerable to chemical exposures.

Keyword:aggregate exposure, environmental justice, built/indoor environment

1054080

High-throughput occupational exposure estimation using workplace compliance data and Bayesian hierarchical modeling

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Abstract: New approaches are needed to rapidly screen the potential exposure and health hazard posed by tens of thousands of chemicals approved for production and use in the United States and elsewhere. High-throughput computational methods have been used to screen substances based on general population exposure potential from sources such as ambient air, consumer products and drinking water. However, worker exposures have significant uncertainties due to high workplace variability in chemical production and use; consequently, these occupational exposures remain relatively uncharacterized for many substances. We present a high-throughput, data-driven approach that leverages a database of over 1.2 million observations of chemical concentrations in U.S. workplace air samples (spanning 1984-2018) to aid in estimating occupational exposure in the U.S. We fit a two-stage Bayesian hierarchical model that uses the North American Industrial Classification System's (NAICS) industry sector and subsector classifications and the physicochemical properties of each substance to predict workplace air concentration distributions. This model greatly outperforms a null model when predicting whether a substance will be detected in an air sample (75.7% detect/non-detect classification accuracy) and, if detected, at what concentration (root-mean-square error of 1.00 log10 mg m-3) when applied to a held-out test set of substances that were not used for training the model. For 57% of the held-out air samples, our model was able to correctly predict both detection or non-detection, and for detects, the measured air concentration within 1 order of magnitude. A null model that did not consider workplace type or physicochemical properties achieved this accuracy on only 35% of samples. We also found that workplace air exposure patterns varied strongly across industry types and physicochemical properties. This modeling framework can be used to predict chemical air exposure distributions for novel or data-poor substances and provide an improved estimate of occupational exposures within the context of high-throughput, risk-based chemical prioritization efforts.

Keyword:occupational exposure, air, Bayesian

1000917

Introduction to the session

L. Stanek; US EPA, Office of Research and Development, Center for Public Health and Environmental Assessment

Abstract: This talk will introduce the session and provide a small amount of background information. The duration will be 5 minutes.

1000917

"Environmental Intelligence" - Quantifying Google Street View derived greenspace exposures and determining it's association with socio-economic factors and self-reported health

M. Nyhan; National University of Ireland - University College Cork

Abstract: In order to manage urban greenspace infrastructure in cities worldwide and unlock its full socio-economic and health benefit potential in an era of rapid urbanization, an improved understanding of urban greenspace metrics and, indeed, the science of urban greenspace, is urgently needed. Therefore, in the first study of its kind, we quantified street-level greenspace metrics using 751,644 Google Street View images and computer vision methods in 125,274 point locations across three major cities in Ireland. We then examined the impact of population-weighted exposure to greenspace on socio-economic and health determinants within and between these three urban areas. Our study demonstrated an extremely scalable approach to the benchmarking of urban green infrastructure and population-weighted exposures to greenspace in high spatial resolution at a national scale. We also observe that people living in areas of high exposure to greenspace have statistically significant ($p<0.001$) higher levels of income, education and self-reported “good or very good health” relative to those resident in areas of lower greenspace and this was evident in all three cities.

1000917

Effect of built-environment on patient health outcomes

P. Dwivedi; University of Maryland

Abstract: The built-environment refers to the settings in which people live, work, and play, and it is defined by human built or human designed spaces and features. Neighborhood conditions and lack of features such as access to public transportation, presence of roadways, and walkability have been linked with physical inactivity and prevalence of obesity and diabetes (Nguyen et al. 2019; Sallis et al. 2009; Burls, 2007; Nutsford et al. 2013). We leveraged Google Street View image data in Utah to construct indicators of neighborhood quality (non-single-family homes, green streets, visible utility wires, crosswalks) by utilizing computer vision models. We assessed the association between these neighborhood characteristics and health outcomes of patients (N = 938,085) at Intermountain Healthcare in Utah, after controlling for individual age, white race, Hispanic ethnicity, any religion, marital status, and health insurance status. Individuals living in communities with more green streets and non-single-family homes were less likely to have adverse health outcomes such as diabetes, uncontrolled diabetes, hypertension and obesity. An increase in visible utility wires overhead was associated with higher prevalence of all examined adverse health outcomes.

1000917

Images and audio data as resources for environmental health

S. Weichenthal; McGill University

Abstract: This presentation will provide an overview of our recent work using images and audio to predict short and long-term exposures to outdoor air pollution.

1000917

Exploring applications of agent-based models in exposure science

J. Minucci; U.S. EPA, Office of Research and Development

Abstract: Agent based models (ABMs) allow us to explore how the behavior, demographic information and social factors of an individual shape their exposure to harmful chemicals. ABMs also exhibit for emergent properties due to interactions between agents, which provide insight into how exposure at the individual level scales up to risk for the population. We will explore various applications of ABMs in exposure science and identify data sources that can inform these models.

1000917
Bridging the information gap of exposure model parameterization by coupling disparate data sources
D. Dawson; U.S. Environmental Protection Agency

Abstract:A major challenge of exposure modeling is parameterizing the underlying algorithms such that exposure estimates are reliable. In the case of modeling exposure to chemicals from consumer product use, scarce and often decades-old data is often used to inform patterns of product use. In recent years, the large-scale, automated collection of consumer product purchase data has moved the analysis of purchase patterns into the realm of "Big Data", allowing for tantalizing insight into potential patterns of exposure. However, consumer purchase behaviors are not directly related to product use patterns. In addition, product use data still relies on survey and diary techniques that are expensive to collect and may not share the same demographic considerations or temporal and spatial scales as consumer purchase datasets. To bridge this gap, modeling frameworks must be created to couple disparate purchase datasets to translate consumer purchase information to consumer use predictions. In this case study, we will develop such a framework to couple a large dataset detailing consumer product purchases in American households (Nielson Company) to a similarly large, but focused consumer product use dataset detailing consumer product use by women (NIH Sister's Study). Using the cross-sectional modeling platform SHEDS-HT (The Stochastic Human Exposure Dose Simulator) and a subset of products and chemicals, we will then compare projected chemical exposure based on either model or survey-data derived model parameterization. The modeling workflow developed here will serve as a useful framework for coupling other consumer use and consumer purchase datasets.

1000917
1,4-Dioxane Case
D. Dawson; U.S. Environmental Protection Agency

Abstract: Using SHEDS-HT to model human and down-the-drain exposure to 1,4-Dioxane (1-4D) to both water consumption and product use, it is being parameterized and validated using publicly available data.

1000917
Uncovering human error in public health research publications using artificial intelligence
N. Grokhowsky; U.S. EPA, Office of Research and Development, Center for Public Health and Environmental Assessment

Abstract: Research is regularly finding new ways to apply artificial intelligence, while artificial intelligence is regularly finding new ways to conduct research. A new and useful application for artificial intelligence to improve research is by identifying and predicting the study locations and topics within a body of research. We applied artificial intelligence methods to published literature to identify the study locations and topics around elevated blood lead levels in children in the US and Canada, and analyzed the results to find the human introduced errors potentially present. The goal of this research is to identify locations and topics that are misrepresented by human introduced error, identify the influences that might have caused the identified bias, and visualize the outcomes to better inform future research directions.

1000917

Pandemic Data Science Hack: Lessons to learn from an eco-epidemiological model of global COVID-19 factors analysis

M. Goldsmith; U.S. EPA, Office of Research and Development

Abstract: Many epidemiological models are developed for anticipating geospatial and temporal needs of populations and disease propagation; models that address the “where” and “when”, but less on the “how.” The objective of this work was to use global COVID-19 “prevalence” data in addition to data from disparate sources and types (genetic, geographical, sociological, cultural, life-style and dietary) and, within a machine learning (Genetic Algorithm Multi-Linear Regression) context, to model the data. Using this strategy, we built an ecological epidemiological (eco-epi) multi-factorial model of global COVID-19 “load” in order to better understand and elucidate disease associations/factors with disease susceptibility and ultimately mitigation; the “hows”. The lessons learned from this eco-epi model suggest, even in the absence of medical intervention (i.e. vaccines, or antibody therapies or small molecule therapies), that there are still rational viral spread mitigation strategies that this model can inform, which could extend to the “individual” level. Although we can’t change our age, genetics and our population density, we can curtail lung insult, diet, and interpersonal distance.